

PROCEEDINGS OF THE FORTY-SEVENTH INDIAN SCIENCE CONGRESS BOMBAY, 1960

PART IV

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PROCEEDINGS OF THE FORTY-SEVENTH INDIAN SCIENCE CONGRESS BOMBAY-1960

PART IV

LATE ABSTRACTS

Section I, Mathematics

1. Bars with Rigidly Reinforced Hyperboloidal Type Notches under Tension.

SISIR CHANDRA DAS, Madras.

Solutions have been obtained for the case of a round bar with a hyperboloid notch when the notched portion has been covered with a rigid material and the bar is under tension in the axial direction.

2. "Now vanishing of Ramanujan's ζ function".

J. M. GANDHI, Patiala.

In this paper it is shown that the problem of proving the non-vanishing of Ramanujan's ζ function defined by

$$x \cdot (1-x) \cdot (1-x^2) \cdot (1-x^3) \cdot \dots)^{24} = \sum_{n=1}^{\infty} \zeta(n) x^n \dots \dots \dots (1)$$

reduces to the proving of the conjecture

$$\zeta(2^\theta n-1) \equiv 0 \pmod{2^\theta} \not\equiv 0 \pmod{2^{\theta+1}} \dots \dots \dots (2)$$

where $2^\theta n-1$ is prime and n is odd. The conjecture 2 has been proved to be true for all values of θ upto $\theta=10$.

Assuming the truth of (2) the author derives the following interesting congruences for ζ function.

$$\zeta((2^\theta n-1)^{4m+1}) \equiv 0 \pmod{2^\theta} \not\equiv 0 \pmod{2^{\theta+1}} \dots \dots \dots (3)$$

$$\zeta((2^\theta n-1)^{4m+2}) - 1 \equiv 0 \pmod{2^\theta} \not\equiv 0 \pmod{2^{\theta+1}} \dots \dots \dots (4)$$

$$\zeta((2^\theta n-1)^{2^{k_m-1}}) \equiv 0 \pmod{2^{\theta+k-1}} \not\equiv 0 \pmod{2^{\theta+k}} \dots \dots \dots (5)$$

where $2^\theta n-1$ is a prime and n is odd, m in (5) is also odd.

The author has also shown that the Lehmer's result that if $\zeta(p)$ never vanishes, p being a prime, $\zeta(p^\beta)$ will never vanish (Duke Math. Jour. 14, (1947) 429-433) follows as a corollary to his congruences (3) and (5).

3. Logarithmic numbers and some theorems on Permutations.

J. M. GANDHI, Patiala.

In this paper the author proves the following canonical generators for the logarithmic number $A_r^{(n)}(1)$ and $A_r^{(n)}(-)$. (The paper was read at the 24th conference of the I.M.S. at Poona and sent for publication in Maths. Student). Namely,

$$A_r^{(n)}(-1) = r^{(n)} A_{r-n}^{(n)}(-1) + r^{(n-1)} \dots \dots \dots (1)$$

$$A_r^{(n)}(1) = r^{(n)} A_{r-n}^{(n)}(1) + (-1)^{r-n+1} r^{(n-1)} \dots \dots \dots (2)$$

where $r^{(n)} = r(r-1)(r-2) \dots (r-n+1)$ and $A_r^{(n)}(t)$ is defined by

$$\sum_{r=0}^{\infty} A_r^{(n)}(t) x^r / r! = x^{n-1} \cdot e^{-tx} / (1-x^n) \dots \dots \dots (3)$$

Then the author shows that his Logarithmic numbers includes Mullin's $\Phi(r)$ defined by $\Phi(r) = \sum_{t=0}^r P_t$ (Amer. Math. Monthly, Vol. 64, 1957, pp. 669-670) as a special case of $A_r^{(n)}(-1)$ when $n=1$.

Author then proves following interesting Asymptotic formulas for Logarithmic numbers.

$$A_r^{(n)}(+1) \approx r! / e. \quad (4), \quad e^2 \approx A_r^{(n)}(-1) / A_r^{(n)}(1) \dots \dots \dots (5)$$

$$\pi \approx 1/2 (A_r^{(n)}(-1))^{r+1} / (A_r^{(n)}(1))^{r-1} \cdot r^{2r+1} \dots \dots \dots (6)$$

In the end the author discusses the function $\theta_k(r)$ defined by $\theta_k(r) = \sum_{t=0}^r (-1)^t (rP_t)^k$ and mentions that the function is as interesting as Salam's $\Phi_k(N)$ defined by $\Phi_k(N) = \sum_{r=1}^N (P_r)^k$ (Amer. Math. Monthly, Vol. 65, pp. 615-616) and notes that $\theta_1(r)$ is identical with $A_r^{(n)}(1)$.

4. A note on square-free integers.

R. P. SRIVASTAV, Lucknow.

Making use of the properties of Mellin Transform, Möbius function $\mu(n)$ and a Tauberian method, two alternative proofs are furnished of the well-known result

$$n(x) \sim \frac{6}{\pi^2} x + O(x^{\frac{1}{2}})$$

where $n(x)$ is the number of square-free integers $\leq x$. The analysis leads to an interesting problem of evaluating $\zeta'(2)$, which seems to be $-\pi^2/12$. However it has not been possible to obtain any proof. The paper is concluded with a theorem on the existence of an infinity of square-free integers occurring in triplets of the form $(4n+1, 4n+2, 4n+3)$. It is proved that if $t(x)$ denotes the number of square-free triplets $\leq x$, then $t(x) \geq x(\frac{6}{\pi^2} - \frac{1}{2}) + O(\sqrt{x})$. From numerical computations carried out in the small ranges it seems that

$$t(x) = \frac{1}{2} (1 - \frac{6}{\pi^2}) x + O(\sqrt{x}).$$

5. A note on the Zeros of Integral Functions.

R. P. SRIVASTAV, Lucknow.

For an integral function $f(z)$ of complex variable $z=re^{i\theta}$ of order ρ , $0 \leq \rho < \infty$, $f(0) \neq 0$, having zeros at $\{a_n\}$, arranged according to nondecreasing moduli, it is proved that

$$\sum a_n^{-q} = -\frac{1}{(q-1)!} \left[D^{q-1} \left\{ \frac{f'(z)}{f(z)} \right\} \right]_{z=0},$$

where q is an integer greater than ρ . The result is useful in summing up certain series and through a very simple argument it leads to Picard's Theorem for integral functions of finite order.

6. Particular Solutions of Einstein's Field=ns.

K. CHANDRA SHEKHAR, Bombay.

In this paper I have discussed the solution

$$\left[\begin{smallmatrix} \nu \\ \lambda \mu \end{smallmatrix} \right] = \left\{ \begin{smallmatrix} \nu \\ \lambda \mu \end{smallmatrix} \right\} + S_{\lambda \mu}^{\nu} + U_{\lambda \mu}^{\nu}$$

of

$$g_{\lambda \mu} ; \nu = 0$$

under the conditions

$$(1) \quad \lambda_{aaf} = 0$$

$$(2) \quad \lambda_{ffa} = 0$$

$$(3) \quad \lambda_{ijk} = 0$$

λ 's being the roots of the $=n$

a ; f takes value from 1 to 2; 3 to 4.
ijk takes values from 1 to 4.

$$a(\lambda) = 0$$

where $a(\lambda)$ is the determinant of the tensor

$$a_{\omega \mu}(\lambda) \equiv \lambda h_{\omega \mu} + k_{\omega \mu}$$

here λ being a parameter or symbolically

$$a(\lambda) \equiv \det ((k_{\mu}^{\nu} - \lambda \delta_{\mu}^{\nu}))$$

where

$$k_{\mu}^{\nu} \equiv h^{\lambda \nu} k_{\mu \lambda}$$

and

$$g_{\lambda \mu} = h_{\lambda \mu} + k_{\lambda \mu}.$$

$g_{\lambda \mu}$, the basic real tensor being non-symmetric $h_{\lambda \mu}$, the symmetric part of $g_{\lambda \mu}$,

$h_{\lambda \mu}$, the Skew-symmetric part of $g_{\lambda \mu}$ and then the effect of the $=n$

$$S_{\lambda} = 0 \quad \text{on the above solutions.}$$

The first part of the paper deals with (1) and (2) cases. The 2nd part is devoted to the case (3).

7. On the Solution of certain Partial Differential Equations.

OMAR ALI SIDDIQI, Aligarh.

Section I. Generalised method of parameters in the solution of Non-Linear partial differential equations.

In the method of parameters given by Srinivasiengar $p = \frac{f_1(x, a)}{\varphi(z, a)}$, $q = \frac{f_1(y, a)}{\varphi(z, a)}$ make the partial differential equation of 1st order $f(p, q, x, y, z) = 0$ an identity on

substitution and the solution is determined on integrating $dz = pdx + qdy$. This method applies to a large number of differential equations of all standard forms and some general linear and non-linear partial differential equations of 1st order in two independent variables. The scope of application is considerably increased by generalising the method. We have given several examples.

Section II. Generalisation to partial differential equations of second order and certain examples discussed.

Section III. The scope of differential equation $\varphi(p, y) = x(q, z)$ is discussed.

Section IV. The form $f_1(p, z, x) = f_2(q, z, y)$ is discussed.

8. Triangular numbers which are squares and the asymptotic behaviour of a (n).

M. A. KAZIM, Aligarh.

It was found by Euler "History of Theory of Neg" Dickson that there occur infinity of triangular numbers which are squares but I have found that there exist two such series as

$$(3 \cdot 2)^2, (17 \cdot 12)^2, (99 \cdot 70)^2, (577 \cdot 408)^2, \dots$$

$$1, (7 \cdot 5)^2, (41 \cdot 29)^2, (239 \cdot 169)^2, \dots$$

If N is any number however big then the number of triangular numbers which are squares lying before N will be asymptotic to $\frac{\log N}{4 \log (1 + \sqrt{2})}$

9. Curves in a four space with non-positive-Definite Metric.

A. C. SHANIHOKE, Delhi.

In 1957 C. C. MacDuffee had studied curves in a four space of signature ~ 2 . In the present paper, curves in a four space of different signatures is studied.

$$\text{Let } ds^2 = \sum_{i,j=1}^4 g_{ij} dx^i dx^j$$

be the metric. Then this is reducible to the form

$$ds^2 = dx^2 + dy^2 + dz^2 - dt^2$$

if the signature be +2.

$$\text{and } ds^2 = dx^2 + dy^2 - dz^2 - dt^2$$

if the signature be zero.

Let us confine at present to f 2.

$$\therefore J = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} \text{ is the matrix of space}$$

$$\text{If } = \Delta \begin{bmatrix} x' & x'' & x''' & x^{iv} \\ y' & y'' & y''' & y^{iv} \\ z' & z'' & z''' & z^{iv} \\ t' & t'' & t''' & t^{iv} \end{bmatrix}$$

then

$H=[h_{ij}]=\Delta^T J \Delta$, Δ^T , being the transpose of Δ . Therefore H is reducible to the signature of J by a matrix of det. J . Let the reduced form be

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & k^2 & 0 & 0 \\ 0 & 0 & k^2 T^2 & 0 \\ 0 & 0 & 0 & 0 - k^2 T^2 S^2 \end{bmatrix}$$

Then Frenet's formula in the form

$\Lambda' = \Lambda Q$ are obtained, where

$$\Lambda = \begin{bmatrix} \lambda_1 & \lambda_2 & \lambda_3 & \lambda_4 \\ \mu_1 & \mu_2 & \mu_3 & \mu_4 \\ \nu_1 & \nu_2 & \nu_3 & \nu_4 \\ k_1 & k_2 & k_3 & k_4 \end{bmatrix} \text{ and } Q = \begin{bmatrix} 0 & -K & 0 & 0 \\ K & 0 & -T & 0 \\ 0 & T & 0 & S \\ 0 & 0 & S & 0 \end{bmatrix}$$

Section II, Statistics

I. PROBABILITY

1. Stochastic Approximation to an Allocation Problem.

S. R. S. VARADHAN, Calcutta.

In certain applications it becomes necessary to maximise a function, subject to certain restrictions. For example a person may like to invest his resources into different investment channels such that for a fixed total investment his total return is a maximum. If the total return is additive, i.e., the sum of individual returns, then we can consider the following mathematical model.

To maximise this function $f_1(x_1) + \dots + f_k(x_k)$ subject to the condition $x_1 + \dots + x_k = \text{Const.}$ When the individual functions are not explicitly known it is not possible to use the tools of Calculus.

In this paper, under suitable conditions on the functions f_i , a method of successive approximations converging in probability to the minimising solution is given if the functions are not known, however assuming that it is possible to observe for any x_1, \dots, x_k a random variable W with expectation $f_1(x_1) + \dots + f_k(x_k)$.

2. Diffusion with continuous supply at the origin.

H. C. GUPTA, Delhi.

In an earlier paper (1950) the author obtained the general formulae for the distribution of particles along a straight line at time t when there is a continuous supply at the origin at the rate $\rho(t)$, the proportion of particles with the velocity $u_1 (>0)$ to those with $u_2 (>0)$ being constant at $c_1 : c_2$ and the intensity of transition from one velocity to another being a constant Q . It is possible to obtain analytical expressions for the distributions only for a few special form of $\rho(t)$. It is, therefore, of some interest to discuss at some length, as is done here, the case $\rho(t) = \exp(h - Q)t$, which includes as a particular case, supply of particles at a constant rate.

II. BIOMETRY

3. Height-Weight Norms and Standards of Gujarat University Students.

D. G. VASHI, Ahmedabad.

The measurements on height and weight were obtained of 3,180 men-students and 2,098 women-students of the University. These students form representative samples of 15% and 50% of the two populations. The age range considered for men is 17-26 and that for women 16-24.

The growths of height and weight are examined by obtaining regressions of each on age, separately for men and women. The norms of height and weight are obtained and they are compared with other available norms of British and American people.

The regressions of weight and height are obtained for two age groups 18 and 19, both for men and women and the height-weight standards were laid down for those age groups. Comparisons of these standards are made with other available standards for British and American people.

The bivariate tables of height and weight for ages 18 and 19 were also subjected to the height-weight requirements for the recruitment to Defence Services of India to find out the percentage of eligible candidates for recruitment.

4. Population Projections for some Language Groups in India.

MISS N. S. SHAUTHAMMA, Mysore.

The object of this paper is to project the population according to the language composition for the 1961 census year. For this purpose a study is made of the language composition in India, as classified by the mother tongue in the 1951 Census data. The 1951 Census had two questions in its Schedule relating to the Languages (1) The Mother Tongue, (2) Bi-Lingualism. An actual enumeration was made relating to these two questions and the data collected for the first question, namely, the mother tongue, have been given in the five different tables under the following headings :—

Table I :—Speakers of Languages, specified in the Constitution.

Table II :—Other Indian Languages (or dialects) with speakers numbering a lakh and over (arranged in order of the number of speakers).

This is distinguished from others by two factors :

(1) They are known to be spoken as the Mother Tongue by the members of scheduled tribes as specified in the Constitution (Schedule tribes order 1950).

(2) The number of speakers of the Languages (or dialects) exceeds one lakh.

Table III :—Other Indian Languages (or dialects) with speakers numbering a lakh and over.

Table IV :—Other Indian Languages (or dialects) with speakers numbering less than a lakh, arranged alphabetically.

Table V :—Non-Indian Languages, arranged alphabetically.

5. Parallel line assay of a local anaesthetic.

N. K. CHAKRAVARTI, Kanpur.

The author has, in a paper to be published in Biometrics, considered biological assay of a local anaesthetic where the unknown preparation is applied in only one concentration and the standard in a number of concentrations. The method was

based on the relationship, found from theoretical considerations, between the response as logit metameter $\log P/Q$, the concentration C and the time elapsed t , which is

$$Y = \log C + \beta C - Kt - \alpha.$$

In the present paper, the case where both the unknown and the standard are applied in r concentrations such that

$$U_i = \lambda C_i, \quad i=1, 2, \dots, r$$

is considered, where U refers to the unknown preparation.

Formulae for estimating the potency λ and its fiducial limits have been given. It is also shown that if the two preparations are administered in unequal number of concentrations, the formulae become more involved, though there is no difficulty in obtaining them.

III. ECONOMETRICS

6. On Dollar-Rupee and Yuan-Rupee Exchange Rates.

T. MAITRA, Calcutta.

This paper raises certain doubts regarding the conventional practice of fixing exchange rates between two currencies and proposes an alternative method of finding out the exchange rates on reasonable economic grounds. Two cases have actually been examined to illustrate the general econometric principles underlying our computation.

IV. DESIGN & EXPERIMENTS

7. Circular Design for Replication Three.

P. N. BHARGAVA, New Delhi.

Das (1959) introduced a circular design. His definition of such a design is that if there be v varieties, the circular design in blocks of K -plots can be obtained from the initial blocks $1, 2, 3, \dots, k$ by obtaining the other blocks as $1+\theta, 2+\theta, \dots, k+\theta$, where θ varies from 1 to $v-1$ and the different numbers are reduced to mod. v . In the same paper he generalised the design for the block size two.

In the present paper an attempt has been made to generalise the definition of the design when the block size is three. If x_1, x_2, x_3 are the three numbers to form the initial block, the remaining blocks can be obtained as $x_1+\theta, x_2+\theta, x_3+\theta$ where θ varies from 1 to $v-1$, and $x_2-x_1=q_1$ (say) and $x_3-x_2=q_2$ (say) may be equal or unequal. The solution has been obtained for two particular cases of such designs when $q_1 (\angle v-1)$ and $q_2 (\angle v-1)$ are equal and when $q_1=2$ and $q_2=1$.

8. Analysis of Variance for a Competitive Experiment.

TADAKAZU OKUNO, Calcutta.

The present paper deals with the way of evaluating the competitive ability in wheat varieties from a group of experiments conducted by Dr. Kanichi Sakai (1) as a part of his research work on competition. The term "competition" includes, in

a broad sense, all biological interactions between coexisting organisms within a limited area. But he wishes to use this term in a narrow sense, as the effect of interaction operating between individuals of different genotypes within a population. Competition will certainly take place also between individuals of the same genotype. But it will probably be impossible to separate the effect of competition from that of environment in an isogenic line. His view on competition has already been reported in detail at the Cold Spring Harbour Symposia on Quantitative Biology held in 1955.

In one of his experiments conducted in 1957 and 1958, ten wheat varieties were tested for their competitive abilities, growing each of the ten in pure-stand, and in mixture with every one of the remaining 9, the total number of plots per replication being 55. Randomized complete block design with 6 replications was used.

9. The use of logical matrices in the construction of confounded designs.

M. NADLER and J. C. REED, Calcutta.

This paper presents a description of the logical matrices and their use in the construction of confounded designs. An historical development of the logical matrix is given. It is shown that hyperspace of m variables taking on s discrete values may be represented by the local matrix which was developed by Svoboda. Operations on this matrix permit determination of the maximum number of confounded effects for any desired block size, given the effects which are to be kept free, the number of solutions available for a given problem, and the assignment of treatment combinations to the key block. The method is completely general and can be used in designs of 2^n and 3^n . Investigation is proceeding to determine the properties of the matrix with respect to designs having different numbers of levels for each factor. The method may be operated manually for designs up to 2^{12} . Extension of the method for punch card techniques is considered. Investigation is also proceeding on rigorous developments of algorithms for designs of 2^n and extension is made to design of 3^n . The main advantages of the logical matrices and that they permit confounding by graphical methods thereby minimizing the possibility of error, solutions may be determined rapidly, and they are useful pedagogically.

V. STATISTICAL METHODS

10. A Note of Pearson's Differential Equation of Certain Bivariate Surfaces.

D. N. LAL and J. DUTTA, Patna.

Karl Pearson obtained the differential equation of his family of curves in the form

$$\frac{1}{y} \frac{dy}{dx} = \frac{a_0 + a_1 x}{b_0 + b_1 x + b_2 x^2}$$

the solutions of which cover some of those well known non-normal distributions which are important in sampling theory.

A simple generalisation of this equation to two variate case is proposed in this paper,

11. An Application of Ordered Statistics.

K. R. AIYAR, Annamalaiagar.

In a recent paper (1) Ostle and Stech have proved that 'if a random variable is symmetrically distributed with a finite variance, then the mean and the range of a random sample are uncorrelated'. Further, it is pointed out in the above paper, by means of an example that symmetry in the distribution is not necessary for zero correlation between the mean and the range of the sample. In this note we examine the correlation between the mean and certain linear function of ordered sample values and derive the results for the symmetrical distributions as special cases.

VI. SPECIALISED APPLICATIONS

12. On Measurement of Discriminating Powers of Achievement Test Items.

A. K. GAYEN, G. D. KAYAL and R. K. MATHUR, Kharagpur.

Considering x-axis to represent the total score on a test and y-axis, the score on a particular item of the test, Lindquist (1939) proposed a graphical analysis for the determination of discriminating power of the item-test. As for a 100-mark question paper of an achievement test it is convenient to have ten ranked intervals on the x-axis, i.e., the intervals, 0-9, 10-19, 20-29,, 90-above of the total score, some sort of Decile Graph was obtained by him by plotting the averages of scores on the terms of the individuals belonging to the above ten ability groups. Lindquist considered items where responses could be classified as either 'correct' or 'incorrect' ('yes' or 'no' question-items) and considered an item to be discriminating at a level of ability where a steep rise of the curve was observed.

The present investigation considers the problem of measurement of discriminating powers of items of which the score y is a variable not necessarily a binomial one, and defines two suitable indices for two different situations for measuring the discriminating powers, that is, intensities of the steepness of rise of the decile graph of the item at different ability levels.

Section V, Geology & Geography

GEOLOGY

1. A Study of Microseisms Recorded at Cochin.

T. D. KARTHA, Cochin.

A microseismic station comprising of E-W, N-S and Z component pendulums has been in operation at the Indian Naval Physical Laboratory, Cochin, since 1953 and more or less continuous data have been collected for the past 5 years. It has been found that mostly short period microseisms of 1-2 seconds period are predominant. Most probably the longer period microseisms were marked by the more predominant short period microseisms. It has also been observed that microseismic activity is most conspicuous during the pre-monsoon and monsoon seasons and could be attributed to local causes such as wind, heavy rains, etc.

Recently the station has been reset with a view to record the storm microseisms which are usually of 4-10 seconds period. This has been done by adjusting the

period of the pendulums to 5 seconds and incorporating suitable filters to reduce the amount of short period microseisms. A complex microseismic storm was recorded during the last week of September, 1959, and this could be attributed to an intense cyclone in the Bay of Bengal. Using a filtering technique it has been possible to separate the long period microseisms associated with this storm from the short period local activity.

2. The Extinction of Dinosaurs.

YOGI S. A. A. RAMAIAH, Bombay.

One of the most fascinating problems in Vertebrate Paleontology is the Extinction of Dinosaurs. In this paper the various theories put forth to explain this extinction including temperature, food, strength, intelligence, limbs and gait are discussed and ultimately shown that OSTEO-ARTHRITIS was the main cause of extinction which is a natural development of over-eating and obesity.

3. The Geology and nature of Karo measures around Makoli, East Bokaro Coalfield, Bihar.

S. M. CASSHYAP, Aligarh.

The paper deals with the geology of a coal-bearing area around Makoli lying lat. $23^{\circ} 45'$ to $23^{\circ} 47'$ and long. $86^{\circ} 0'$. The only subdivision of the lower Gondwanas present here is the Barakar. Sandstones are particularly dominant of which two varieties have been recognised. Whitish, coarse grained and compact is the one variety of sandstones which is more prominent and occupies the greater part of the area. The brown micaceous sandstone forms the second variety and is less significant.

The only productive seam to occur here is the Karo seam. The term 'measures' is used in preference to 'Seam' as the Karo seam occurs generally as more than one seam separated by bands of shale and sandstone. The main seams of the Karo measures, known as the Top Karo and Bottom Karo, crop-out along the banks of river Damodar.

Five coal seams have been found to occur in the Makoli area. They have been correlated with the main seams of the Karo measures.

Fermor's formula $a=100(g-k)$ was applied to these coals and the conclusions thus derived show a slight superiority of the bottom portion over the top. The values of ash contents, so calculated, when plotted against their respective specific gravities, show a linear relationship.

4. Stratigraphy of the Sausar Group of Rocks, to the South Amgaon, Narsinghpur District, Madhya Pradesh.

M. G. PAITHANKAR, Jabalpur.

During the systematic geological mapping of the area to the south of Amgaon, ($22^{\circ} 45' - 22^{\circ} 50' : 79^{\circ} - 79^{\circ} 8'$), Narsinghpur district, Madhya Pradesh, a group of metamorphic rocks belonging to the Sausar Series were mapped and studied in the laboratory.

These rocks have been correlated with the Sausar series. The stratigraphical sequence of the Sausar series was worked out earlier by L. L. Fermor (1949). Recently on the basis of extensive and intensive field work by the Geological

Survey of India in parts of Nagpur, Bhandara and Balaghat districts, Shukla and Anandalwar (1959) have with certain modifications re-established the sequence for the Sausar Series. The rocks of the area under consideration are more suitably correlated with the later succession as the presence of mica schists between white and pink marbles or between diopside gneiss and pink marbles has not been noticed in the area. Moreover the mica schists overlie the marbles. The chlorite schist in this succession however has to be fitted into its position above the Bichua stage, which is the Sapghota stage of Fermor. Magnetite bearing mica schist which occurs above the Chlorite schist also included in the Sapghota stage.

It seems that the rocks of this area belonging to the Sausar Series represent the northward extension of the type area extending underneath the Gondwanas and the Traps. The absence of manganese in this area indicates that this formed the shore facies of the Sausar basin and that the manganese was mostly formed in the central parts in special zones.

5. Occurrence of the Lametabeds near Shrinagar, District Narsinghpur, Madhya Pradesh.

M. G. PAITHANKAR and P. C. TANEJA, Jabalpur.

During the systematic geological mapping of the area around Shrinagar, (23°-23° 53' : 79° 30'-79° 38') district Narsinghpur, Madhya Pradesh, an occurrence of sedimentary limestone has been recorded for the first time. This limestone has been correlated with the Lameta limestone.

The limestone occurs in two patches. The exposure to the north east of Shrinagar strikes N.N.E. to S.S.W. and dips with 35° to the south east. It overlies unconformably on the Jabalpur sandstone and to the north is faulted against the calcareous crystallines. The thickness at Majni is about 70 feet.

The second exposure to the west of Umargarh Reserve forest is comparatively thin and dips gently towards south-south east.

The limestone is usually grey in colour but at times it is pinkish. It is usually quite compact and small particles of quartz and jasper are abundantly embedded. Seven samples have been studied in the laboratory. Sp. Gr. is 2.64 (average). The arithmetic mean size of Quartz ranged from .1 to .5 mm. Quartz particles are mostly angular.

Though no fossils have been recovered by the authors the limestones have been correlated with the Lametas (Lower Main limestones) on the following two characters viz. Limestone overlies the Jabalpurs and underlies the Deccan traps and that the character of this limestone is similar to that of the type area at Jabalpur.

These limestones are considered to be of undoubted sedimentary origin.

6. "Analysis and Mechanics of Faulting at Jabalpur, M.P."

M. G. PAITHANKAR, Jabalpur.

Sedimentaries comprising of the Jabalpur Group of rocks belonging to the Upper Gondwana period, conformably succeeded by the Lameta beds are found well developed around Jabalpur. Trap outliers are also seen on several hill tops. The rocks have a regional strike of E.N.E. to W.S.W. and the sedimentaries dip gently towards N.N.W.

The area is traversed by a series of strike faults approximately E.N.E. to W.S.W. They have all of them their down throws to the S.S.E. and they provide

an excellent example of step faulting. The throw of the faults varies from 20' to over 70' and the faults are all post-trappean in age.

Following are the main features regarding the Jabalpur faults, that lead us to certain conclusions regarding their origin.

(1) All faults strike nearly E.N.E. to W.S.W. with their down throws to the south or south west. The faults are all post-trappean in age.

(2) These faults are exclusively restricted to the Jabalpur group, the Lametas and the Deccan Traps and no similar faults of this age have been observed in the adjoining archaen rocks.

(3) All faults die towards W.S.W. and extend variously in the E.N.E. direction and the amount of down throws also decreases towards W.S.W. and increases towards E.N.E.

(4) The down throw and the length of the northerly faults is less it increases in case of southern faults.

(5) Northern faults are nearly strike faults (e.g. Chui hill fault and the factory fault) whereas the southern faults are strike slip faults (e.g. Pat Baba Ridge fault, Marjadlia valley fault) i.e. there is also a horizontal displacement along the strike of the fault planes.

It is concluded that the severity of the force that caused these faults was more in the south than in the north. It is further concluded that the absence of faults of this age in the metamorphics of this area means that the force causing these faults was not regional over the entire area but only restricted to area with sedimentaries and the overlying traps.

The fault plane of the strike fault or the strike slip fault is always vertical or at a high angle. The usual conditions for strike slip faults are (i) Greatest and least pressure acting horizontally, (ii) Intermediate pressure in a vertical direction, the fault plane is developed parallel to the intermediate pressure.

Regarding the source of the distorting force the author thinks that possibly it is connected with the consolidation of the basalt sheets of the Deccan Traps and as such the shear is restricted to the areas with Deccan Traps. Resulting contraction of the basalt flows must have resulted in to large compressional pressure in the horizontal plane and acting on the Deccan Trap itself and also on the underlying loose sedimentaries belonging to the Lametas and the Jabalpurs. It is interesting to note that the traps are thick in the south and south east and thin out towards north and north west, forming something like a wedge. As such the resulting compressional pressure must have been more in the south east than in the north west.

This results into a horizontal compressional differential pressure in the S.E. N.W. direction. This corresponds with the short axis of the strain ellipsoid, the short axis being parallel with the greater pressure. This suits well with the ideal condition for the formation of strike faults and strike-slip faults. Vertical or high angled shears must have been first formed in the Deccan traps these being easily transmitted into the underlying sedimentaries. Further the severity of the resulting force being more in the south than in the north, the length, the throw and the associated horizontal strike slip of the resulting faults is more in the case of southern faults.

7. Albitised basalt of Bombay and the associated intertrappeans: A preliminary survey.

R. N. SUKHESWALA, Bombay.

Earlier a suggestion was made about the existence of albitised basalt showing pillow character in the island of Bombay ($18^{\circ} 53' : 19^{\circ} 3' \text{ N. and } 72^{\circ} 47' : 72^{\circ} 52' \text{ E.}$). The present paper, based mainly on field evidences and supported by few preli-

minary laboratory investigations, is written with a view to understand and visualize the conditions under which albite basalt with pillow structure could have originated. It is concluded that in the early stages the lavas in the Bombay area had erupted in shallow waters or an estuary; and in the process of albitisation the lake or estuary waters aided by the alkali-charged solutions from the parent tholeiitic magma played a dominant role.

8. Clouded Plagioclase Felspars from the type Charnockite Area of Sir Thomas Holland.

P. R. J. NAIDU, Madras.

Several dykes have intruded the charnockites of Pallavaram, the type area of Sir Thomas Holland. No metamorphic effects are noticed in them. The dykes constitute a consanguinous series, ranging from olivine-dolerites to Augite-diorites. Clouding occurs in Augite-diorites which have a micropegmatitic base. Cloudiness is related to deuteric effects within this dyke.

9. Structural control for Gold Mineralisation in Ramagiri Schist Belt, Anantapur District, Andhra Pradesh.

M. KRISHNA MURTY, Madras.

Detailed structural mapping of the old Ramagiri gold field in Anantapur District, Andhra Pradesh, was carried out with a view to assess the economic possibilities of this abandoned gold field. The geological formations in the area consist of Pre-cambrian metavolcanic rocks, namely greenstones, (meta-basalts) with pillow structures, flow breccia, sericite-chlorite phyllites, ferruginous quartzites, meta-gabbros, acid tuffs and sericite-quartz schists, occurring in low grade metamorphism equivalent to "greenschist facies". The geological structure of the area consists of the main schist belt west of Ramagiri forming a north plunging syncline, which is cross-folded south of Ramagiri into a south plunging anticlinal cross-fold, now occupied by Ramagiri granites, followed by a synclinal cross-fold, which makes up the enlarged Ramagiri east schist belt. The Ramagiri gold field is located on the western limb of this cross-folded syncline. The profuse injection of vein quartz and the highly sheared, drag-folded and schisted nature of the meta-gabbros, ferruginous quartzites and acid tuffs along the central core of the mineralized belt suggest a major shear zone following the synclinal axis of the cross-fold. The greenstones and sericite-chlorite phyllites along the Ramagiri mining belt reveal enechelon drag-folding plunging north.

The main auriferous tract of Ramagiri Gold field consists of a quartz vein zone, about 500 feet in width, extending over a north-south strike distance of about eight miles from south Jibutil mines in the south, through Ramagiri mines in the centre, to Chennabhavi mines in the north. The gold quartz mineralisation is localized within sericite-chlorite phyllites along the western limb of the south plunging cross-folded syncline. The mineralisation has followed shear fractures and cleavages accompanying en-echelon drag-folding of the phyllites and greenstones. The lodes strike N.-S. to N.E.-S.W. and dip steeply east. The ore shoots along the lodes pitch north in conformity with the plunge of the en-echelon drag-folds. In addition to the main zone of mineralization, there are quartz-ankerite veins, ferruginous gossans and other minor quartz veins in the belt.

There is a lithologic control for gold-quartz mineralization within the incompetent units of sericite-chlorite phyllite. The gold-quartz veins are localized along

the west limb of the cross-folded Ramagiri East syncline. The south plunge of the cross-folded syncline of Ramagiri east schist belt and the complementary anticline to its west, as indicated by predominantly south pointing lineations, has been produced as a result of shear couple involving east block north and down movement in relation to the west block south and up movement. The mineralized belt of Ramagiri gold field reveals westward en-echelon shifting of the geological formations and the quartz veins as one proceeds north. A predominant north plunge of the drag-folds, is indicated by the shallow north plunging lineations in the sericite chlorite phyllites along the old mine workings. The drag-folds have been produced as a result of east block north and up movement in relation to west block south and down movement. The ore-shoots and quartz-veins in the mineralised belt exhibit north pitch at 45° . The gold-bearing quartz veins and stringers indicate mineralization along en-echelon shear fractures or fracture cleavage developed in the incompetent phyllites as a result of intense en-echelon drag-folding.

Thus, there are remarkable controls, both structural and lithological, in the localization of gold mineralisation in the Ramagiri Gold Field, which will be of great economic significance for the exploration and development of the lodes.

10. Granite in the Eastern Margin of the Cuddupah Basin.

R. N. P. AROGYASWAMY and M. S. BALASUNDARAM, Calcutta.

The portion of the Cuddupah basin was examined earlier by King and Foote (1872), but because of the great complexity, no precise data regarding the structure and tectonics was given. The margin was generally recognised to be faulted, and complex fold systems were also recorded close to it. Broad undulations called "domes" by King also presented a serious problem to satisfactory interpretation.

The presence of thrusts and occurrences of granite in Somasila gorge of the Penner had been recorded earlier by one of us (M. S. Balasundaram). The sedimentaries (Cumbums and Krishna quartzites) comprise a large thickness of Shales slates and phyllites (Cumbums) and quartzites (Krishnas).

Granitic outcrops are seen at the foot of the hills to the NW of Somasila. The rock is foliated, migmatitic and almost gneissose. The strike of foliation is conformable to that of the sedimentaries i.e. NW-SE while the dip is nearly vertical. At the crest the quartzites form a capping. Massive, practically unfoliated granite is more common near the base of the hill, away from the contact with the sediments, while nearer to the sedimentary contact foliated, migmatitic varieties predominate. In this area large rafts and inclusions of sedimentary material, e.g., shales, shaly phyllites, quartzites etc. can be seen in abundance. These inclusions yet preserve the same strike and dip of foliation as the parent material (Cumbums). Some of the inclusions shows gradation from foliated shaly phyllites to foliated migmatites.

This section of the Penner shows that the Nallamalais (Cumbums) have been subjected to migmatitisation to a considerable degree. Agmatites possibly constitute a preliminary phase in the process, followed by feldspathisation and the introduction of quartz in the form of blebs, streaks or stringers.

The granite appears to be partially syntectonic (Kinematic) and partly post tectonic, and had possibly been mobilised during the post Cuddupah Orogeny.

Miniature "peel" sets have also been observed in this section.

A traverse in the Venukonda dome of King also reveals the same relationship of the granites to the sedimentaries.

11. Some aspects of eolian sedimentation on shore lines.

R. N. P. AROGYASWAMY, Calcutta.

Certain eolian sedimentary features observed on the beach between Villanganni and Karikal on the coast of Tanjore district (Madras State) have been described.

1. Shore line ripple marks (eolian).
2. Shore line ripple marks (eolian) interference type.
3. Patchy concentration of heavy black minerals.
4. Erosional lineation.

The use of these features in sedimentological studies have been briefly indicated.

12. Certain structures in the Upper Gondwana rocks near Ongur.

R. N. P. AROGYASWAMY, Calcutta.

The patch of Upper Gondwana rocks consisting mainly of laminated khaki or brown coloured shales and intercalated salmon pink, medium grained sandstones, occurs to the SSE of Madras between mile 64 and 62 on the Southern Trunk Road, near Ongur ($12^{\circ} 20' : 79^{\circ} 47'$) topo sheet 57 P/15.

This area had been mapped by Foote in the latter part of the 19th century but no particular reference has been made to the structure, or nature of the rock types occurring therein. A resurvey of the area was done by Venkatram (1954) who has given a brief description of the rock types.

Khaki or brown coloured laminated shales constitute the major rock type. At places the shales are rust coloured and lateritised. By far the larger portion of the shales, however appear to be calcareous to a slight extent as revealed by the development of kankar, especially along the water course. Medium grained, pink clayey sandstone occurs as thin bands and intercalations in the shales. The general strike of the formations is NNE-SSW, and the dip is of the order of 12° - 15° to the WNW. The sandy patches contain rounded pebbles of metamorphic rocks, dolerite, and occasionally limestone.

The sandstone intercalations, in the shales, appear to be mainly in the forms of "intrusive sills or dykes". Occurrences of sandstone dykes was reported earlier by the author. Structure resembling, load cast and flame have been found on the underside of the comparatively thin sandstone intercalations. This association suggests a common genetic relationship. It is probable that large scale slumping, of deltaic sediments within the shelf region, had given rise to the dykes of sandstones, in the more massive shales, while sandstone sills or intercalation shales, were produced where shale was bedded. The presence of load cast structures on the under side of the sandstone intercalation as well as flames, suggests that there was relative movement of the sediments concerned while in an hydroplastic state, simulating conditions obtaining in turbidity currents.

GEOGRAPHY

13. A reconnaissance Geographical study of village Nildoh :

B. K. BIDWAI, Nagpur.

The paper is a preliminary survey of a village situated at a distance of about 6 miles to the S.W. of Nagpur. The study is divided into 2 parts : (1) Physical aspects, (2) Human aspect. The physical aspect deals with the salient features of

relief and drainage, climate, water-supply and soils. The human aspect deals with the people and their activities with a relatively detailed treatment of land-use and house-types. The paper poses a few problems, a detailed investigation of which will be of great help in planning the "city-region" of Nagpur.

14. Problems of Labour Supply in Australian New Guinea.

MOHAMMAD ANAS, Aligarh.

Australian New Guinea, consisting the Territory of Papua and the Trust Territory of New Guinea (jointly administered by Australia), is a primitive country in which European economic interest has been established over a number of years. The European demand for native labour has created certain problems which need attention.

The paper attempts to focus attention on these problems and examines the various factors which govern the labour supply. On the one hand it takes into consideration the density and distribution of population, the system of native land use and land tenure, the maximum labour force which the villages can spare, and the expansion of the general and native economic activities. On the other hand it takes into account government policy regarding areas open to recruitment (the minimum age of employment) conditions of work and the wage level.

The paper concludes on the note that Government policy since the Second World War has not been in favour of the employers. Nonetheless, even a short visit to a labour compound or shanty town is enough to convince one that much remains to be done as far as labour welfare is concerned.

15. Seasonal Studies on the Flora of Nainital.

R. K. GUPTA, Pondicherry.

The ecological conditions of a certain place can be represented by a formula $t \times s \times l \times v$ (GAUSSEN) and various zones for the whole country can be made based on this formula. Seasonal studies on the vegetation of Nainital has been given which shows the approximate number of species flowering in each month of the year. Based on these studies it is considered that the approximate flora of a certain zone having same ecological conditions can be predicted and the approximate number of species flowering in each month of the year can be calculated, keeping in view the geographical position, biotic factors, direction and aspect of the slopes in the hills.

16. Flood Control Problems in Bihar.

SHARDA PRASAD, Patna.

Bihar particularly North Bihar, is frequently visited by heavy floods, causing a wave of miseries and devastation to Land, property and life. In its wake thousands of villages are wiped out, valuable agricultural lands are spoiled and malaria and other diseases take a toll of life. Traffic is dislocated for many days. Thus the gigantic, hydrologic, Geo-economic and social problem which goes with the floods is colossal and cries for an immediate solution. Being the monsoon land, the bursting of clouds is the primary cause of floods but their ferocity and frequency are augmented by the man's interference with the nature—deforestation, flood plain occupancy, failures of engineering structures and defective agricultural practices.

The various control measures have been discussed and their utility emphasised upon. The solutions lie in exhaustive experiments with hydraulic models and testing of soils to ascertain suitable measures for flood control as well as for keeping them in a well defined course.

17. Ibn Khaldun's concept of the Origin Growth and Decay of Cities.

SHAH MANZOOR ALAM, Hyderabad.

The paper attempts at a critical analysis and a comparative study of Ibn Khaldun's exposition of the principles of urbanization.

In the fourth chapter of his Prologomena, Ibn Khaldun deals exhaustively with the various, natural and cultural, factors which are responsible for the rise and fall of cities. Dealing with the latitudinal distribution of cities he establishes that they are mainly determined by the climatic factors. Regions of temperate climate only abound in cities and civilization.

Ibn Khaldun enumerates a number of physiographic factors which should be considered while siting a town and concludes that only those cities continue to prosper, without break, whose site and situation respond favourably to the changing requirements of the society.

Like Griffith Taylor, Ibn Khaldun also believed in a 'Cycle of City Evolution.' Every metropolitan city had humble beginning and the ecological processes of competition, co-operation, conflict, dominance and succession operate in the evolution of each one of them. The city also grows like an animal organism and having reached its optimum development begins to decline.

Lewis Mumford considers the city to be a social emergent. So does Ibn Khaldun. He regards the social and political forces paramount in governing the location and growth of cities. The city represents the optimum stage in the development of human civilization.

Ibn Khaldun did not attempt to define a city. Like the urban ecologists, of the present age, he always pointed out the characteristics whenever he desired to distinguish one city from the other or a rural area with that of urban. He, recognised a close inter-dependence between a city and its rural hinterland. He also suggested a broad classification of cities according to their age, size and function. He however, failed to fully apprehend the economic factors behind the growth of cities.

The city owes its origin to the rise of a dynasty and with its fall the progress of the city is also checked and it ultimately decays. The city, however, can escape this self annihilating process provided, there is no break in the continuity of its political successions, it commands a rich and populous hinterland and has a geopolitical pull.

Ibn Khaldun considers civilization to be cast in the mould of constant change and continuous movement, and the city presents a synoptic view of these shifting scenes of civilization. The city reflects the characteristics of its age, carries the impress of its past and epitomizes the ideals of the civilization it represents. It is an inevitable link in the evolution of human society and an expression of superior civilization. And like the civilization itself the city is also subject to the organic law of growth and decay.

18. Rainfall Regions of Andhra Pradesh.

B. N. CHATURVEDI, Hyderabad.

This paper incorporates a study of the distribution of rainfall in the State. For the purpose of drawing the isohyets, out of a total of 209 Rain gauge stations for

which the figures are available for 30 years or more, 185 stations have been selected, at least one station for each tahsil. The average of the interocetage has been used instead of the Normals as suggested by P. R. Crows of Glasgow University with modifications. Annual and Seasonal Rainfall figures have been made use of to divide the State into regions and sub-regions. The Isohytes of the annual rainfall form the boundaries of major regions and the isohyets of the retreating monsoon (October-November) mark the boundaries of the sub-regions.

Throughout the State, the rainfall varies between 25" and 45" with two notable exceptions. A small area of 150 square miles in the hills of East Godavari and another of 98 square miles in Srikakulam districts around Parvathipur, get an average rainfall of 48" to 58". The amount of rainfall decreases generally from the coast towards the interior. Based on the total annual rainfall figures, the State can be divided into the following regions :—

1. The Moderate Rainfall Region (35"—55").
2. The Low Rainfall Region (25"—35").
3. The Scanty Rainfall Region (Less than 25").

Less than one-sixth of the area of the State in the South-western corner falls in the scanty rainfall region. The moderate rainfall region comprises the coastal lowlands and the hill ranges in the north and east and the lower Godavari Basin. The rest of the State lies in the Low Rainfall Region.

The rainfall received during the retreating monsoon season serves to divide the Moderate Rainfall Region further into sub-regions as follows :—

- I-A : The area getting its rainfall mostly during South-west monsoon period and receiving less than 10" in the Retreating Monsoon period.
- I-B : Where major portion of the rainfall comes from the South-west monsoon but the rainfall from the retreating monsoon is also more than 10".
- I-C : The area getting major portion of its rainfall in the Retreating Monsoon period.

19. Crop Associations of District Kheri (U.P.).

UJAGIR SINGH and LAXMI NARAIN, Varanasi.

The district of Kheri, which mostly forms a part of the Eastern Tarai of U.P., can be Sub-divided into two agricultural regions :—

- A—The Rice Region, which constitutes roughly over $\frac{2}{3}$ rd. of the district, and in which rice occupies $\frac{1}{3}$ rd. of the total cultivated acreage and,
- B—The wheat Barley Region, which covers less than $\frac{1}{3}$ rd. of the district, in which these crops cover over $\frac{1}{3}$ rd. of the total cultivated land.

In the former two crop, associations can be distinguished :—

- (i) Rice-Maize-Wheat-Kodon Association, and
- (ii) Rice-Wheat-Sugarcane Association.

In the latter two other crops—rice and sugarcane form the Association.

20. Changing Patterns of Crop Land use in the Ganga-Yamuna Doab.

MOHD. SHAFI, Aligarh.

This paper is a part of the programme of research in the understanding of the forces which bring about changes in the patterns of cropland use in the whole of Uttar Pradesh. The acreage data for the study of crop patterns have been drawn from the unpublished records of the statistics of agricultural years 1945-46 and 1955-56 Paragna wise, for the whole of the Doab. The procedure in acquiring a picture of the relative positions of strength among the crops of the Doab was to obtain the ranks of a number of selected major crops for each Paragna

by order of the percentage of total harvested cropland occupied by each crop. Maps have been prepared showing crops ranking first, second and third, Paragana wise, for the agricultural years 1945-46 and 1955-56. A summation of the accumulated patterns of change among the major crops as a group was also considered. For each Paragana and abbreviated fraction was prepared showing the increase and decrease of the selected crops. The increase was indicated by numerator and the decrease by denominator. From these percentage figures a map has been prepared showing the total volume of change in the cropland use in the decade. With the help of the above mentioned summation analysis two additional maps have been prepared showing the crops which made the largest increase or suffered the largest decrease. The investigation helps in the understanding of the trends in crop production in relation to the geographical environment.

Section VI. Botany

1. Labiatae of Sagar and its Neighbourhood.

J. S. SHUKLA, Sagar.

The Labiatae are characterised by the presence of glandular hairs, which secrete various types of essential oils. These aromatic plants can be easily identified by their bi-labiate corolla and the gynobasic style. Several members of the family are of medicinal importance, i.e., *Ocimum sanctum*, Linn., *O. basilicum* Linn., *Mentha viridis* L. and some like *Salvia splendens* Ker-gawl., *Salvia coccinea* Linn., *Coleus malabaricus* Benth. and *Coleus inflatus* Benth. etc. being ornamental are grown in gardens.

Sagar is located at 23°51' N. Lat., 78°45' E. long. and at an altitude of 1731 ft. above sea-level in a hilly tract of N.W. part of Madhya Pradesh. The hills belong to Deccan-trap, Vindhyan range (upper cretaceous) consisting of basaltic rocks. There are mixed type of forests in the vicinity of Sagar. The valleys are mostly under cultivation while barren patches are under grasses. These valleys are traversed by some small streams. Average annual rain fall is 48 inches.

Hooker has reported 55 genera and 335 species of Labiatae from India. Haines has described 10 genera and 3 species from Southern Circle of Madhya Pradesh. Kenoyer has given an account of only 5 species from old Gwalior State (now in Madhya Pradesh) Graham recorded 8 genera of the family from Nagpur (formerly in M.P.). No further work has been done since then.

During several collection tours round about Sagar 23 species belonging to 14 genera have been collected. Out of these *Hyptis suaveolens* Poit., *Leucas linifolia* Spreng., *Plectranthus incanus* Link., *Nepeta ruderalis* Hammit. are new records for Madhya Pradesh.

Plants of this family grow in open fields, meadows or plateaux of hill-slopes. However, *Nepeta ruderalis* Hammit., *Colebrookia oppositifolia* Sm. *Pogostemon plectranthoides* Desf. grow in ravines, on stream banks or in moist fields. The occurrence of these plants in these localities clearly indicates that they love moist environments. *Anisochilus eriocephalus* Benth., *A. carnosus* Wall. and *Leonotis nepetaefolia* R. Br. have been found attaining abnormal heights in calcareous soils.

2. On some Abnormal Female Receptacles of *Marchantia* L.

S. BHATTACHARYYA and C. K. C. S. PILLAI, Sagar.

An examination of *Marchantia palmata* Nees. and *M. nepalensis* L. et L. collected from Darjeeling, Eastern Himalayas, 8000 ft., showed a few abnormal specimens.

Marchantia palmata Nees. In one specimen of this species two sterile rays of the female receptacle had been replaced by two thalli each bearing a single gemma cup.

Marchantia nepalensis L. et. L.

Specimen I. The female receptacular heads in this specimen are somewhat crumpled and distorted and had developed thalli bearing gemma cups of the usual type.

Specimen II. In this specimen the thallus tapered suddenly and merged into the stalk of a female receptacle which instead of being vertical lay horizontally in the same plane as the thallus.

3. On the cuticle of *Thinnfeldia sahnii* Seward.

A. R. RAO and K. M. LELE, Lucknow.

Recent cuticular studies have established some fundamental differences between the epidermal features of *Thinnfeldia* and *Dicroidium*. Formerly they were distinguished purely on morphological differences.

A couple of specimens referred to *Thinnfeldia sahnii* Seward on morphological criteria are shown to possess cuticular features more like those of *Dicroidium* than *Thinnfeldia*. In view of this it is suggested that the species *Thinnfeldia sahnii* Seward should be placed under *Dicroidium*.

4. Foliar sclereids of *Mimusops hexandra* Roxb.

A. R. RAO and MISS V. Vaswani, Lucknow.

Young and old leaves were studied by clearing them, macerating and also by sectioning them. It was found that the sclereids are rather meagre in the young leaf. In the older ones they become plentiful and occur in variously branched forms often extending from the upper epidermis to the lower epidermis. In the older leaves the scleroids accompany dying and old vascular bundles of the leaf veins. The scleroids are at first thin walled, later their lumen is reduced very much due to the walls becoming highly thickened, but the thickness does not show any stratification. Pit canals reported by earlier workers in the sclereids of *M. ebengi* and *M. hexandra* were not observed by us.

Ontogenetical studies show that the sclereids are differentiated from the palisade parenchyma. Stages showing the gradual conversion of a palisade cell into a sclereid can be seen. A layer of parenchymatous cells below the hypodermis also cuts off cells which occur singly or in groups and become stretched both vertically as well as horizontally into sclereids. These further become branched, the lateral branches being generally thinner than the main branch.

5. Natural interspecific hybrids in *Amaranthus* L.

P. P. KHANNA, H. B. SINGH and R. PRASAD, New Delhi.

The genus *Amaranthus* includes species which are cultivated for grain on the highlands of both the Old and the New World. Several species are popular as greens and some others are common weeds of field crops.

The *Amaranthus* in general are known for their ability to hybridize and some naturally occurring interspecific hybrids have earlier been reported from Europe.

In the Division of Botany at Indian Agricultural Research Institute, a large collection of species and varieties of *Amaranthus* has been under study for taxonomic and evolution purposes. Amongst the plants raised from open-pollinated seeds of various species, the following hybrids were detected :

A : In the 3-stamen group :

1. *A. viridis* L. x *A. gangeticus* L. (New hybrid)
2. *A. polygamus* L. x *A. gangeticus* L. (New hybrid)
3. *A. lividus* L. x *A. gangeticus* L. (New hybrid)

B : In the 5-stamen group :

1. *A. cruentus* L. x *A. leucocarpus* S. Wats
2. *A. dubius* Mart ex Thellung x *A. spinosus* L.

A. lividus (♀) was observed to cross freely with *A. gangeticus*. Hybrids 2 and 3 of the A group and first of the B-group were completely pollen sterile, whereas others had 1-4% stainable pollen. There was however, no seed setting in any of the hybrids. The parent species showed 90 to 100% pollen fertility. All hybrids exhibited distinct hybrid vigour.

The sterile nature of the various hybrids shows that the parent species may have independent phylogenetic relationship.

The F₁ hybrids also indicate the dominance of certain characters such as non-dehiscent nature of the utricle of *A. viridis*, the axillary and terminal inflorescence of *A. gangeticus* (in cross with *A. lividus* which is mainly axillary) and the presence of female flowers only in axillary clusters and at the basal portions of the spikes of the branched inflorescence (a character of *A. spinosus*).

6. Foliose and Fruticose Lichens from Assam and North East Frontier Agency of India.

D. D. AWASTHI, Lucknow.

A collection of about 150 specimens of the foliose and fruticose lichens, made from Assam and the North-East Frontier Agency (NEFA) during the years 1956-58 by Rolla Sheshagiri Rao and G. Panigrahi of the Botanical Survey of India, had been placed at the disposal of the author for determination. It has now been almost completely worked out and found to comprise 65 species under 18 genera belonging to nine families namely, Collemaceae, Pannariaceae, Stictaceae, Peltigeraceae, Cladoniaceae, Umbilicariaceae, Parmeliaceae, Usneaceae and Physciaceae. A majority of the species are such that are already known from the different parts of the Himalayas and as such their report from this area shows the extent of their distribution. However, few species are of special interest such as *Anzia physoides* A. L. Smith—a species founded on a sterile material and now collected for the first time in fertile condition confirms its retention in the genus *Anzia*; *Usnea cladonioides* (Nyl.) DR.—an endemic but rare lichen of the Himalayas; *Cetraria asahinae* Sato and *Usnea asahinai* Mot. which were so far known from Japan only and are now known from this area showing the extension of distribution to the Eastern Himalayas. A specimen of the genus *Lobaria* has provisionally been determined as a new species.

In the collection the maximum number of species belong to the genus *Usnea* (14 spp.) followed by *Parmelia* (10 spp.) and *Cladonia* (7 spp.). It has not been possible to determine a few more specimens of the last genus (*Cladonia*) to the specific level on account of either their sterile nature or they were rather too small.

Though meagre lichen collections had been made from Assam in the past but probably the collection from NEFA happen to be first of its kind from that area.

7. Plant Collection in North Garhwal with the I.A.F. Expedition of 1959.

M. A. RAU, Dehra Dun.

During October 1959, the Indian Air Force organised a Scientific-cum-Mountaineering Expedition to the Nilakantha-Chaukamba region of North Garhwal. The author who was attached to the Expedition as a botanist collected plants in the Khiraun, Rishiganga, Alaknanda and Saraswathi-Arwa river valleys in the altitude range 2000 to 4500 metres. This paper gives an account of the vegetation of the area as observed during the period of visit and which yielded more than 300 species of Flowering plants, ferns and mosses. The paper is illustrated with Kodachrome color transparencies.

8. Fern Flora of Sagar, Madhya Pradesh.

K. S. TRIPATHI, Sagar.

The ferns are characterised by the presence of dorsal or marginal sporangia, each sporangium encircled by a complete or incomplete elastic ring, collected in sori with or without a covering (indusium). Beddome (1892) has reported 98 genera of ferns excluding the families Marsileaceae and Salviniaceae.

Sagar is located in Madhya Pradesh towards its northern boundary at latitude 23°50' N. and longitude 78°50' E. and at an altitude of nearly 2,000 feet above the sea-level. The monthly minimum and maximum temperatures on an average are 52°F. and 77°F. in January, and 78.5°F. and 105°F. in May. Annual average rainfall is 48 inches. In the neighbourhood of Sagar 6 genera and 7 species of ferns have been uptill now recorded. According to Copeland (1947) the various genera belong to the following families.

Family—Pteridaceae :

The author collected *Cheilanthes argentea* (Kunze) from the shady and marshy slopes facing toward north of Khanpur forest and *Adiantum caudatum* and *A. lunulatum* from Garhpara, Patharia, Rahatgarh and Khanpur forests. The last two are known as 'walking ferns'. *Actiniopteris australis* (Link.) was collected from Sagar fort, Garhpara forest and fort. It is known as 'fan fern' due to its appearance.

Family—Parkeriaceae :

Ceratopteris thalictroides (Linn) was collected by the author from Rahatgarh from a ditch on the left bank of river. Due to linear, succulent and pod like fertile segment it is generally known as 'horn fern'.

Family—Marsileaceae

Marsilea quadrifoliata—It is typically subaquatic fern growing on mud in and around the Sagar lake. Rhizome is creeping and solanostelic. Frond with four opposite leaflets at the end of long stipe. Sporangia are in hard structure called sporocarp. Sori consist of microsporangia and megasporangia.

Family : Salviniaceae :

Azolla species. It is minute free floating fern found in Sagar lake. Fronds are in two rows, each consisting of a floating upper lobe and a submerged lower lobe, always harboring *Anabaena*. Sori are borne on lower lobe in pairs and each enclosed by its indusium.

9. Root apical organization in some Monocotyledons.

B. N. MULAY and MRS. A. PILLAI, Pilani.

Investigations in this laboratory on monocotyledonous root apices have brought out that the following types of organization are met with in the species listed below :—

I. A common mass of initials in the centre from which all histogens arise. This is found in *Cypripedium speciosum*, *Peristeria elata*, *Liparis atropurpurea*, *Phajus albus*, *Microstylis wallichii*, *Phajus wallichii*, *Eulophia herbacea*, *Eria bambusifolia*, *Dracaena angustifolia*, *Aloe vera*, *Zingiber officinale*, *Musa sapientum*, *M. paradisiaca*, *Ravenala madagascariensis*, *Heliconia illustris*, *Dioscorea alata*, *D. sativa*, *D. hispida*, *D. pentaphylla*, *D. wallichii*, and *D. esculenta*, *Areca lutescens*, *Cocos nucifera*, *Phoenix dactylifera*, *P. sylvestris*, *Cyrtostechys lakka*.

II. The calyptrogen has no histogenetic relation with the root body. Protoderm, periblem and plerome arise from a common group of initials. This is found in *Calanthe veratifolia* and *Microstylis rheedi*.

III. Protoderm and root cap originate from common initials. Periblem and plerome are independent in origin. This type is found in *Cymbidium glifolium*, *Scilla indica*, *Urginea indica*, *Lilium longifolium*, *Polygonatum oppositifolium*, *Aspidistra lurida*, *variegata*, *Hemerocallis flava*, *H. fulva*, *Chlorophytum elatum*, *C. sternbergianum*, *C. orchidastrum*, *Lilium tuberosum*, *Anthericum variegatum*, *Arthropodium cirrhatum*, *Sansevieria thyrsiflora*, *S. hahnii*, *Zephyranthus tubispatha*, *Amaryllis belladonna*, *Eucharis grandiflora*.

IV. Protoderm and periblem when traced towards the apical region, seem to merge into a group of initials from which the root cap is also formed. Plerome originates independently. This type is found in *Dracaena surculosa*, *Crinum latifolium*, *Haemanthus coccineus*, *Agapanthus africanus*, *Anthurium candidum*, *Yucca aloifolia*, *Tupistra clarkii*.

V. Calyptrogen independent, protoderm-periblem complex, and plerome is independent. This type is found in *Habenaria cephalotes*, *Sorghum halipense*, *S. vulgare*, *Setaria verticillata*, *Cenchrus ciliaris*, *Digitaria sanguinalis*, *Kaempferia galanga*, *K. rotunda*, *Hedychium coronarium*, *Curcuma aromatica*, *Zingiber zerumbet*, *Alpinia calcarata*, *Curcuma longa*, *Costus speciosus*, *Elettaria cardamomum*, *Canna indica*, *C. edulis*, *Maranta variegata*, *M. zebrina*, *M. major*, *Stromanthe sanguinea*, *Phrynium capilatum*, *Calathca zebrina*, *Xyris anceps* and *X. schoenoides*. In *Maranta arundinacea* there are two superimposed tiers of protoderm-periblem complex of which the outer gives rise to the dermatogen, and hypodermis only while the inner gives rise to the cortex.

VI. All four histogens, calyptrogen, dermatogen, periblem and plerome, are independent. This type is found in *Eulophia pratensis*, *Microstylis densiflora*, *Grammatophyllum speciosum*, *Epidendrum radicans*, *Coelogyne barbata*, *Eria nana*, *Calanthe Nveitchii*, *Vanda teres*, *Dendrobium densiflorum*, *Cymbopogon flexuosus*.

10. Charophytes in Western India in Relation to pH Values and Bottom-Type of Water Systems.

ELLA A. GONZALES and B. S. VAIDY, Bombay.

A survey of water systems in Western India was made to determine the occurrence of Charophytes with respect to pH values and bottom-type. Species of Charophytes found here usually thrived in waters which fluctuated between the acidic and alkaline ranges. Ecorticate forms of Charophytes were usually found

in waters which fluctuated towards the acidic range while the corticate forms were found in abundance in waters which fluctuated towards the alkaline range. Charophytes did not grow well in pieces of water with sandy bottom but grew luxuriantly where there was more silting. Periodicity of Charophytes was also studied. A few new records of Charophytes for this region are claimed.

Section VII., Zoology & Entomology

1. Pineal Organ in Fishes—*Mystus tingara*.

K. C. BOSE, Ranchi.

The study of the pineal organ in Fishes can give definite clue to the much discussed points about the origin and nature of this organ in general. The study of the Pineal organ in *Mystus tingara*, shows that it is very well developed and for the first time in these fishes such well developed pineal organ has been observed. It arises as a single median structure from the roof of the thalamencephalon in between the habencular and the posterior commissure and it never shows any sign of bilateral origin. In these fishes an exceptionally long pineal tract terminating to an end organ, the pineal organ, has been observed. This organ lies in a foramen called pineal foramen.

The histological structure of the Pineal organ strongly indicates the glandular nature of this organ. There are two types of cells—one with larger nuclei and the other with smaller nuclei. The cells are pigmented and the smaller ones are more glandular than the larger ones. There is no cell wall distinguishable in between the cells and their nuclei are seen imbedded in the network of protoplasm.

Some secretory patches are found in the lumen of the pineal organ which is in continuation with the ventricle through the lumen present in the pineal tract. The pineal organ has some sort of glandular function and is not a degenerate structure.

2. Pineal foramen in Siluroid fishes.

K. C. BOSE, Ranchi.

The author has studied the Pineal foramen in the following fishes—*Mystus aor*, *Mystus seenghala*, *Wallago attu*, *Bagarius bagarius*, *Rita rita*, *Clarius batrachius*, *Entropiichthys vacha* and *Pseudotropius garua*. The pineal foramen in *Mystus aor* is described here.

So far this foramen was known as a fontanelle. (Bhimachar '33, Gregory '33). Klinckostroem observed a Pineal foramen in *Callichthys asper* (acatfish) but according to him the Pineal organ is not developed in this fish and so does not reach the pineal foramen.

In *Mystus aor*, the foramen lies in a groove, called by the author as pineal groove, in between the frontal and supraethmoid bone. In this fish the cranial wall is said to have come to lie secondarily superficially. As such the whole of the dorsal part of the cranium except the pineal groove is practically naked. The pineal groove is covered with a thick skin covering.

In *Mystus aor* the foramen is more or less oval in shape. In the adult fish (3 feet in length) the length of the foramen is 24 mm. and the breadth 3.5 mm.

and it lies partly in the frontal and partly in the prefrontal regions on the dorsal surface of the cavum cranii. In fact the two horn like processes of the supra-ethmoid bone form the anterior one third boundary and the rest two third of the foramen is covered by the two frontals. In this foramen lies the Pineal organ which is a glandular structure.

Section IX, Medical and Veterinary Sciences

1. Studies on heritability and genetic correlation of some characters of economic importance—II: (i) Interval between first two calvings, (ii) Yield of milk in the second lactation.

H. V. DADLANI, S. V. CHANDIRAMANI, and P. BHATTACHARYA, Izatnagar.

Records of 74 dam-daughter pairs involving 10 sires in the Haryana breeding herd at the Indian Veterinary Research Institute, Izatnagar, were studied in respect to the first calving interval and yield of milk in the second lactation.

Mean, its S.E. and coefficient of variation for calving interval in these dams and their daughters were: 427.24 days and 461.00 days, 9.69 days and 16.00 days, and 19.52% and 29.85% respectively. Similar statistical values in respect to milk yield were: 3218.23 lb. and 2578.78 lb., 156.90 lb. and 130.30 lb. and 41.94% and 43.47% respectively.

Heritability coefficient was low ($+0.0184 \pm 0.448$) for calving interval, but rather high ($+0.4300 \pm 0.226$) for milk yield. Little improvement was, therefore, expected from further selection for calving interval, but the expectation for milk yield was rather good.

Phenotypic and genetic correlations between the calving interval and milk yield were $+0.1572$ and $+0.1870$ respectively.

Positive genetic correlation between calving interval and milk yield indicated that the breeding in the past had been guided by selection for both these traits. These correlations help in establishing a selection index for a breeding herd.

Section X, Agricultural Sciences

1. The Prospects of Flint X Dent Hybrids in Maize.

S. VITTAL RAO, Hyderabad.

Maize in India is used as human food. The yield averages to 700 lbs. for acre. In these days of food crisis, the replacement of open pollinated maize by suitable hybrids will greatly step up food production. As a result of trial with 57 hybrids from U.S.A. at 22 locations in India, some hybrids significantly outyielded the locals. Though these hybrids have a superior germplasm, the seeds are dented. Indian farmers prefer a flint type of seed.

Due to the availability of superior germplasm from the principal maize growing regions of the world, there are prospects of building suitable hybrid with a desired grain type. The flint x dent crosses appear to be the answer. Just like in Italy, India is also building up flint dent hybrids. The results are encouraging. Efforts

are to be intensified to get proper flint x dent combinations with desired hardness of grain, ease to multiply, resistance to pests and diseases and of required maturity period. Great emphasis is being laid on the duration of maturity as it has to fit into the cropping pattern of India. Some of the dent hybrids of United States are slightly late in maturity and thus have disadvantage for straight away introduction.

2. Study of the Effect of Differential Irrigation and Levels of Nitrogen on Physical Properties of Cotton.

T. V. KRISHNAN and R. L. N. IYENGAR, Bombay.

Improvement in the quality of cotton is one of the items of high priority in the national economy. This could be achieved either by breeding superior varieties of cotton or by adopting appropriate agronomic practices. The latter aspect is dealt with in the present paper.

The data deals with irrigation-cum-manurial experiments. Eightyone samples of 320F cotton grown at Faridkot, combining three frequencies and three intensities of irrigation with three levels of nitrogen and three replications, were studied. The system of lay-out was split-plot design with frequencies x intensities of irrigation in main plots and levels of nitrogen in sub-plots. The results obtained showed that lint weight, seed weight, ginning percentage and fibre-fineness were not affected by any of the treatments significantly. Mean fibre-length was increased by increase in quantity of water used in irrigation. Moderate irrigation was beneficial for bundle-strength of fibres. Fibres were more regular in length and more mature for maximum levels of nitrogen, though results showed that addition of nitrogen itself should be dictated primarily by considerations of yield. On the whole, it was observed that irrigation improved the fibre-properties of cotton.

3. Hydrogen-ion concentration in relation to nitrogen utilization by *Colletotrichum falcatum* Went.

A. K. MOHD. GHOUSE and ABRAR M. KHAN, Aligarh.

The effect of thirty-one different nitrogen sources on the rate of growth of *Colletotrichum falcatum* Went in relation to changes in pH of the medium has been studied. When the isolate is grown in medium containing phenyl alanine, Dl. tryptophan, Dl. lysine, L. histidine, L. cystine, L. cysteine, isobutyric acid, ammonium sulphate or ammonium nitrate the medium becomes more acidic. In the latter two (ammonium sulphate and ammonium nitrate) the change in hydrogen-ion concentration is very rapid and consequently the growth is also poor. However, with the addition of calcium carbonate or phosphate buffer of Sorensen, the change in pH is controlled and the growth is restored. Medium tends to become alkaline in potassium nitrate, Dl. aspartic acid, L. glutamic acid, Dl. and L. asparagin, glycine, Dl. alanine, Dl. valine, sarcosine, creatine, L. arginine and urea. The initial pH is maintained in peptone, beta alanine, norvaline, L. leucine, Dl. isoleucine, tyrosine and sodium nitrite. In Dl. methionine, Dl. valine, L. arginine and urea there is a decrease in pH in the early period of incubation followed by an increase at a later stage of growth.

4. The influence of different carbon sources on the rate of growth of *Colletotrichum falcatum* Went.

A. K. MOHD. GHOUSE and ABRAR M. KHAN, Aligarh.

The influence of twenty different carbon sources on the rate of growth of *Colletotrichum falcatum* Went has been determined. The growth is good in L. arabinose, lactose, maltose, D. mannitol, D. sorbitol and glycerol; moderate in D. xylose, D. glucose, levulose, rhamnose, cellobiose, melibiose, sucrose, raffinose and dextrin; and poor in D. galactose, D. mannose, L. sorbose, starch and dulcitol. In all the di and poly saccharides, pentoses and glycerol high initial growth takes place. On the other hand the initial growth in hexoses is poor. Autolysis of the mycelium has been observed in arabinose, xylose, levulose, cellobiose and raffinose.

5. The attractiveness of plants to the root-knot nematode, *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949. I. Excised roots of vegetable seedlings.

ASAD AHMED and ABRAR M. KHAN, Aligarh.

The effect of excised roots of thirty-seven vegetable seedlings on larvae of the root-knot nematode, *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949 was studied. Marked variations in attractiveness were exhibited by the roots of different vegetables. Excised roots of the different varieties of lima beans, Chinese cabbage, European cabbage, cauliflower, knol-khol, lettuce, mustard, onion, radish, turnip, vegetable marrow, cucumber, water melon, pumpkin, chola beans, bottle gourd and bitter gourd showed profound attractiveness to the nematodes and considerably high percentage of larvae aggregated round the roots. Distinct repellent effect on the larvae was shown by the roots of varieties of pea, radish, Poona spinach, muskmelon, indigenous spinachs methi and chowlai, and Indian flat beans. On the other hand, excised roots of varieties of pole beans, dwarf French beans, carrot, egg plant, lettuce, mustard, pea, tomato, Indian corn, okra, indigenous spinach chakwat and snake gourd displayed a neutral effect on larvae of *M. incognita*. Many larvae entered the roots during the course of the experiment. Larval entrance was highest in roots of pumpkin and Chinese cabbage for as many as 50 per cent of the attracted larvae were found inside the roots.

6. The attractiveness of plants to the root-knot nematode, *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949. II. Excised roots of ornamental plants.

ASAD AHMED and ABRAR M. KHAN, Aligarh.

The behaviour of the larvae of the root-knot nematode, *Meloidogyne incognita* towards the excised roots of seedlings of thirty-four common ornamental plants has been studied. Profound attractiveness to larvae was shown by the seedling-roots of amaranthus, balsam, brachycome, cacalia, celosia, cineraria, corn flower, hollyhock, marigold, morning glory, nigella and zinnia and high percentage of larvae was found in the vicinity of the roots. On the other hand, excised roots of dimorphotheca, eschscholtzia, leptosyne, nasturtium, and viscaria displayed a decidedly repellent effect on the nematodes. Seedling-roots of alyssum, antirrhinum,

aster, browallia, calliopsis, candytuft, chrysanthemum, dahlia, dianthus, gypsophila, helichrysum, petunia, phacelia, phlox, poppy, salvia and sweet pea exhibited neutral effect on the larvae of *M. incognita* as larval attraction was almost 50 per cent.

7. The attractiveness of plants to the root-knot nematode, *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949. III. Excised roots of tobacco (*Nicotiana tabacum* L., and *N. rustica* L.) seedlings.

ASAD AHMED and ABRAR M. KHAN, Aligarh.

The attractiveness of the excised roots of seedlings of thirteen tobacco (*Nicotiana tabacum* L., and *N. rustica* L.) varieties to larvae of the root-knot nematode, *Meloidogyne incognita* has been determined. Majority of the varieties tested viz., *N. tabacum* var. S. 20, T 17, N.P. 60 and *N. rustica* var. N.P.S. 219, Motihari and Farukhabad local showed a more or less neutral effect on the larvae. However, *N. tabacum* var. G 6, K 20, K 49 and Gursahaiganj local exhibited distinct attractiveness to the larvae. Repellent effect was displayed by the excised roots of *N. tabacum* var. N.P. 70, WAF Natu and *N. rustica* var. T. 238. In general the different varieties grouped under 'Biri tobaccos' are somewhat attractive, whereas the 'Chewing' and 'Hookah' tobaccos, with some exceptions, behaved as more or less neutral towards the larvae. Larval entrance into the roots was poor in all the varieties.

8. The attractiveness of plants to the root-knot nematode, *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949. IV. Excised roots of some weeds.

ASAD AHMED and ABRAR M. KHAN, Aligarh.

Profound attractiveness on the larvae was displayed by the excised roots of *Corchorus acutangulus* Lam., *Euphorbia hirta* L., *Lathyrus aphaca* L., *Solanum nigrum* L., and *Spergula arvensis* L. The roots of *Datura metel* L. and *Melilotus* sp. showed slightly repellent effect. Majority of the weeds viz., *Anagallis arvensis* L., *Argemone mexicana* L., *Chenopodium album* L., *Cynodon dactylon* Per., *Peucedanum graveolens* B. & H., *Portulaca oleracea* L., *Rumex dentatus* L., *Senebiera pinnatifida* DC., *Sonchus oleraceus* L., *Stellaria media* L., and *Trianthema monogyna* L. exhibited neutral effect. Larval entrance into the roots was very poor.

The 'attractive' and 'repellent' agents have no relationship with the susceptibility of plants. Highly susceptible plants may not be highly attractive, and may emit distinctly repellent agents. Roots of normally-resistant plants can emanate substances attractive to the nematodes.

The attractive agent does not appear to be identical with the factor responsible for stimulating larval hatching in *M. incognita*, since plants yielding highly potent root-diffusates have proved to be neutral or repellent towards the larvae. However, attractiveness might be related to the taxonomic position of the plants, for most of the cucurbits, crucifers and composites have displayed profound attractiveness to the nematodes.

9. The influence of temperature and hydrogen-ion concentration on larval hatching in Javanese root-knot nematode, *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949.

ASAD AHMED and ABRAR M. KHAN, Aligarh.

Root-leachings of okra (*Hibiscus esculentus* L.) were used as the hatching medium and they were found to exercise stimulatory effect on hatching. Poor hatching occurred at low temperatures viz., 10° and 15°C. However, larval hatching increased rapidly with a corresponding increases in temperature, and optimum hatching occurred at 30°C. Further increase in temperature did no longer favour hatching and a sharp decline was observed at 35°C. Hatching was almost completely arrested at 40°C.

The hydrogen-ion concentration of the medium had a profound influence on larval hatching. No hatching occurred at pH 2 and 3. However, hatching started at pH 4 and increased rapidly with a corresponding increase in pH. Optimum hatching occurred at pH 7. Hydrogen-ion concentrations above 7 did not favour hatching, and a rapid decline is observed at pH 8. Larval hatching was further reduced at pH 9 and only a few larvae hatched at pH 10.

M. javanica differs from *M. incognita* in that the optimum temperature for hatching in the former is 30°, whereas in the latter is 25°C. However, the optimum hydrogen-ion concentration for hatching in both species is the same.

10. Further studies on susceptibility of common weeds to the root-knot nematode, *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949.

ASAD AHMED and ABRAR M. KHAN, Aligarh.

Host-range of the root-knot nematode, *Meloidogyne incognita* (Kofoid and White, 1919) Chitwood, 1949 and common weeds, growing in winter has been investigated. Out of the sixteen species tested, thirteen proved to be susceptible and only three resistant. *Datura metel* L., and *Anagallis arvensis* L. proved to be highly susceptible (susceptibility rating 3-4) to root-knot. Moderate to light infection was shown by *Amaranthus blitum* L., *Peucedanum graveolens* B. & H., *Rumex dentatus* L., *Senebiera pinnatifida* DC., *Portulaca oleracea* L. and *Spergula arvensis* L. (rating 2-3). Extremely light infection was shown by *Tribulus terrestris* L., *Ocimum basilicum* L., *Asphodelus tenuifolius* Cavan., *Oxalis corniculata* L., and *Sonchus oleraceus* L. (rating 1-2). On the other hand, *Heliotropium strigosum* Willd, *Argemone mexicana* L., and *Cynodon dactylon* Pers. behaved as resistant to *M. incognita* (rating 0).

The high susceptibility to root-knot displayed by members of the families Solanaceae and Amarantaceae has been discussed.

11. Relationship of nitrification to CO₂ evolution.

K. N. SYNGHAL, Patiala.

In order to find out whether a relationship exists between nitrate accumulation and carbon dioxide evolution on the mineralization of soils, four soils were taken. The study revealed that there exists a close relationship between the two. There were a slight variations which were expected in the biological data like this.

12. Amperometric titration procedure for determining $K_2Cr_2O_7$ used in organic carbon determination.

K. N. SYNGHAL, Patiala.

An accurate procedure for determining excess of $K_2Cr_2O_7$ used in the determination of organic carbon by wet digestion method was devised. The method in brief is the determination of liberated iodine amperometrically using a platinum electrode. The procedure gave concordant results when determinations were made on fifty Alberta soils collected from six soil zones.

13. Analysis of drought resistance in wheat.

R. D. ASANA, New Delhi.

Rainfall during wheat season in North India is scanty and, therefore, it was considered appropriate to study the effect of drought on characters directly related to yield. Under adequate soil moisture ear number had the most dominant effect on yield, whereas under moisture stress grain number per ear, and sometimes 1000-grain weight, had as much effect as ear number on yield. Further studies showed that even at the permanent wilting stage of the foliage, the water content of the ear was reduced to a very small extent. Drought reduced immediately grain number per ear, while 1000-grain weight and grain weight per ear were reduced at a later stage (about 4 weeks after dehiscence). During the first 4 weeks after dehiscence, leaves and stem yellowed more quickly under drought, while the ear remained as green as under adequate water supply. Subsequently 1000-grain weight and grain weight per ear increased at a slower rate under drought and the ear yellowed faster. During this period leaves and stem were almost completely yellow. Losses in shoot weight and in sugar content of stem in time did not run parallel with rates of increase in grain weight.

Section XIII, Engineering & Metallurgy

1. Photo-Elastic Investigation for Block Type Concrete Sleepers for Railways.

P. B. CHAULIA, New Delhi, and S. KRISHNAN, Bangalore.

Photo-elastic investigation on the stress distribution in block type concrete railway sleepers has been carried out. Measurements made on a model supported on hard rubber have been compared with the theoretical results obtained by treating the sleeper as a beam on elastic foundation. Calculations for the design of steel reinforcements for the concrete sleepers and a device for testing their strength in the Laboratory have also been included.

2. Some Investigations on Metal Disc Delay Dielectrics.

(MISS) C. DHANALAKSHMI and S. K. CHATTERJEE, Bangalore.

The phase change Φ undergone by microwaves when transmitted through an artificial dielectric composed of metallic discs arranged in a three dimensional array have been derived with different approaches as follows: (i) molecular theory, (ii) electromagnetic theory, (iii) transmission line theory. The phase change de-

depends on the distance t that the wave traverses inside the dielectric and also the spacing d between the centre to centre of any two adjacent discs in the three principal directions. Molecular theory indicates Φ as an increasing function of t , whereas the other two theories indicate Φ as an oscillatory function of t . The transmission line theory also exhibits Φ to be real or imaginary depending on t . Experimental values of Φ as a function of t have been obtained with the help of a microwave interferometer (3.2 cms. wavelength) with an accuracy of ± 0.016 radians for two dielectric samples having spacing d as 1.91 cms. and 2.22 cms. respectively.

3. Impedance of Surface Waveguide.

S. K. CHATTERJEE and (MRS) R. CHATTERJEE, Bangalore.

Expressions for the longitudinal and transverse impedances of a circular cylindrical conductor imbedded coaxially in two different dielectrics, when excited to support H, E and He waves have been derived. It is shown that under certain conditions, the expressions yield the impedances for a surface wave line consisting of a circular cylindrical conductor immersed in air. The real and imaginary parts of the impedances have been separated.

4. Circuit Breakers for High Voltages.

M. P. VARSHNEY, Kharagpur.

Lot of controversy seems to prevail among rival manufacturers of low-oil-content and air-blast circuit breakers which are the only two types suitable for high voltages in the range 66-220 kV. The paper discusses the operational features and the principle of arc extinction employed, underlining the important differences.

The short circuit breaking capacity for low-oil-content breakers is practically independent of the natural frequency of the circuit as against air-blast breakers where it is limited at high frequencies. On the other hand air-blast breakers are ideally suited for automatic rapid reclosing that is coming more and more into use for clearing transient faults, which in fact constitute a great majority of the total number of faults. The paper also touches upon the testing techniques for guaranteeing the very high breaking capacities necessary now-a-days.

In a big station where a large number of circuit breakers are installed, the cost of compressed air plant and pipe line is comparatively small, so that air-blast circuit breakers can be advantageous. For small stations, on the other hand, low-oil-content circuit breakers may prove better.

5. Theory and Application of 3 Phase AC Commutator Shunt Motor.

R. P. ASHTHANA, Baroda.

Modern industrial technology lays great emphasis on the essential manufacturing operations being carried out at maximum possible efficiencies under all working conditions. One of the most important factors that enables such maximum-efficiency operations being effectively carried out is the variation of speed of certain key equipments. For varying speeds of these equipments under pre-set control conditions an efficient yet cheap, and wide-range, variable-speed motor is called for. The D.C. Shunt motor, that maintains its speed constant after the speed has once been adjusted to a desired value, is indeed a near ideal motor for this pur-

pose; but on modern energy supply installations, that are generally 3 phase A.C., it can be used only when accompanied by costly converting appliances; and therefore, because of the inordinately heavy overall costs involved in its use, it is not employed in modern industrial establishments to any great extent. The single-phase A.C. commutator motor as a variable speed motor need not be considered in the present connection because of its low efficiency and great cost. The Schrage-type 3-phase variable speed A.C. motor is indeed a highly efficient motor; but it has too many working elements in it, and all these elements taken together raise its cost to about four times that of a slip-ring motor of the same output. Thus, in the present market there is no suitable 3-phase A.C. variable speed motor that serves the needs of industry in an all-round manner.

The 3-phase Commutator Plain shunt type motor, a possible variable speed motor for the present day industry, has so far remained confined to academic studies; and because of its supposed inherent low efficiency and low power factor, as well as because the earlier motor constructed had bad commutation properties, it has never come into commercial use. Recently, detailed studies have been made on the theory and design of this motor; and it has been found that with its only two (simple) windings and one commutator, and all the problems of low efficiency and low power factor as also of bad commutation fairly well solved, this motor becomes a serious competitor to the Schrage-type motor. It is efficient as also, cheap; actually it will cost, if manufactured on mass scale, just a little more than a slip-ring motor of a similar output.

Practically the whole of the work discussed in this paper was done by the author in his private laboratory; and finishing touches to it were given while he took up office as honorary professor of electrical engineering at the M.S. University, Baroda.

6. A simple method of Calibrating Phase Shifting Transformer.

P. S. SWAMY and D. S. MURTY.

If there are two sinusoids 'A' and 'B' of the same frequency and has ' ϕ ' the phase difference, then the amplitude of 'A' is first adjusted to be unity as indicated by the Valve Voltmeter. The sinusoid 'A' reversed and added to the sinusoid 'B'. The resultant voltage has been adjusted to be minimum by varying the voltage of the sinusoid 'B'. The reading of the Valve Voltmeter is $\sin \phi$ from which the angle ' ϕ ' can be determined.

This method is extremely simple and has been used for calibrating phase shifting transformer. Lead or Lag has been first determined by adding R.C. phase shifting network in the rotor phase.

Using this method Phase Shifting Transformer manufactured by Zenith & Co., has been calibrated. This method of calibration of phase difference is commendable from the point of view of quickness and accuracy.

7. Study of the Citrate Complex of Aluminium (III).

RABINDRA KUMAR PATTNAIK and S. PANI, Burla.

Citrate complex of trivalent aluminium has been investigated by PH titration method within the PH range 2.5 to 7.0. A neutral complex C is first formed at the lower PH range by the reaction.



The equilibrium constant of this reaction has been found to be 1.95×10^{-5} . The complex C dissociated in two steps like a dibasic acid to complexes C_1^- and C_2^{--} with increase in PH. The first and the second dissociation constants are 3.225×10^{-4} and 1.616×10^{-7} respectively.

The probable structures of the complexes C, C_1^- and C_2^{--} are discussed.

8. "Studies on heat transfer between solid particles and liquid fluidizing medium in a fluidizing bed".

S. NARSINHA RAO and RAMALINGAM KAPARTHI, Hyderabad.

Very low heat transfer coefficients between particles and fluids were reported for gas fluidized beds. Use of liquid as the fluidizing medium will solve some of the troubles of gas fluidized beds. The heat transfer coefficients between the particles and the fluidizing medium using unsteady state conditions are determined by transient heating of cold water stream, with hot solid particles in a specially designed liquid fluidizing column. Heat transfer coefficients varying from 113 to 620 B.T.U./ (hr.) (Sq. ft.) (°F) are obtained and these values increase with increase in particle diameter and mass velocity. The present work is compared with previous published data on gas fluidized beds and a suitable correlation of the experimental data is developed.

9. "Studies in recovery of Sulfur from Coal".

K. VASUDEVA and V. A. ALTEKAR, Bombay.

Feasibility of recovering elemental sulfur from coal has been studied. The first part of the paper deals with the recovery of pyrites from Nowrozabad coal which is reported to contain 0.8 to 1.3% pyritic sulfur. Gravity concentration process contemplated on the basis of intensive sink and float tests carried out in this laboratory, on the various size fractions of the coal under question was tried on the laboratory equipment like heavymedia separator, jig, Wilfley table etc. A good quality concentrate (42% sulfur) with a fairly high recovery was obtained. An attractive feature, on which is based the economics of the process, is the recovery of substantial amount of acceptable grade boiler fuel.

Recovery of elemental sulfur from recovered pyrites has been attempted by chlorination reactions. A thermodynamic approach to the optimum reaction conditions like temperature, pressure, ratio of reactants, gas composition etc. has been made. Occurrence of a number of molecular species of sulfur namely S_2 , S_6 and S_8 offers certain unique features not encountered in most other reactions. The recovered pyrites being fine in size fluidized bed rather than the fined bed lends itself as a better means of carrying out the reaction. In addition it offers other advantages like large surface area exposed, better temperature control, easy heat addition or removal, absence of moving parts, absence of local hot spots resulting into localised fusion of mass etc. for this purpose a 2" fluidized column was assembled in this laboratory and was equipped with heating arrangement, temperature control auxiliaries etc. Studies were carried out on the fluidization characteristics of pyrites in air at room temperature and later chlorination reactions were carried out with a view to study the influence of temperature, gas rates, fluidization conditions, gas composition etc. on the quality and yield of products. The results obtained in the laboratory have been suitably presented and the paper also includes, in brief, the suggestions and conclusions based on the experimental results.

10. Contact angle measurements in aqueous solutions of sodium oleate.

DR. V. A. ALTEKAR and D. D. AKERKAR, Bombay.

The contact angles of air bubbles on polished pyrolusite surface in aqueous solutions of sodium oleate, at various concentrations were measured. A plot of contact angle vs. PH, shows the angle to be maximum in the pH region 4-7; and decreases as the pH increases; at critical pH complete wetting is noted. However transferring the particle to distilled water restores the full maximum contact angle (89—90°), at lower concentrations of the collector. This has been explained as a reversal of affected soap molecules with increasing pH. The decrease in surface free energies for this system is calculated.

DISCUSSION

I. RIESZ SUMMABILITY OF INFINITE SERIES

Section of Mathematics

Chairman : PROF. V. G. IYER, Annamalaiagar.

1. T. PATI: *Consistency Theorems.*

By ' $P \subset Q$ ' we mean that summability P is less effective than summability Q . The so-called 'first theorem of consistency for Riesz summability' states that $(R, \lambda, k) \subset (R, \lambda, k')$ for every $k' > k \geq 0$. The analogue of this for absolute Riesz summability, due to Obrechhoff (1929), is: $|R, \lambda, k| \subset |R, \lambda, k'|$ for every $k' > k \geq 0$. These results show that the effectiveness of a Riesz method increases with the 'order', if the 'type' remains fixed. In particular, they show that Riesz methods of positive order are 'regular' or 'absolutely regular' according as the method is ordinary or absolute. The question of the relative effectiveness of any two Riesz methods of different types, but the same order, naturally arises. The first answer to this question is the classical 'second theorem of consistency' of Hardy and Riesz (1915), viz., $(R, e^{\lambda n}, k) \subset (R, \lambda_n, k)$, $k \geq 0$, of which a generalisation by Hardy (1916) states: $(R, \lambda_n, k) \subset (R, \mu_n, k)$, where μ is a logarithmico-exponential function of λ , such that $\mu = O(\lambda^\Delta)$, for some finite constant Δ . The more general result of Hirst (1932) has been studied profoundly by Kuttner (1951), (1952), who shows that in case k is an integer, the conditions of Hirst's theorem which are not only sufficient, but also necessary, can be put in the form of a single condition:

$$(*) \quad \int_A^w t^k |\varphi^{(k+1)}(t)| dt = O\{\varphi(w)\},$$

For the case of non-integral order, Kuttner shows that the analogue of (*), with the $(k+1)$ th fractional derivative of $\varphi(t)$, is neither necessary nor sufficient for the result: $(R, \lambda_n, k) \subset (R, \varphi(\lambda_n), k)$. He has also obtained a necessary and sufficient condition to cover both the cases, but this condition is less satisfactory than (*) in the case of integral order.

The direct analogue for absolute summability of Hardy's theorem was proved in 1942 by Chandrasekharan. In 1954 (QJM, Oxford) Pati gave a generalisation of Chandrasekharan's theorem. A parallel theorem for non-integral order was given by Prasad and Pati in 1957 (Trans. Amer. Math. Soc.). Meanwhile, for integral order, an improvement upon the theorem of Pati was made by Guha (J. London M. S., 1956), who also gave a theorem for non-integral order. But this latter theorem of Guha involves a condition which has been left unanalysed, and is therefore rather artificial. The latest theorem of Prasad and Pati (Proc. International Congress of Mathematicians, 1958) remedies this defect, while Pati has also refined the proofs of Guha's theorems in several ways.

2. S. R. SINHA (Allahabad) : *Strong Riesz Summability.*

1. Let $\sum a_n$ be a given infinite series, and λ_n a positive monotonic increasing function of n , tending to infinity with n . For $r > -1$, we write

$$A_{\lambda}^r(w) = \sum_{\lambda_n < w} (w - \lambda_n)^r a_n,$$

and

$$A_{\lambda}^0(w) = A_{\lambda}(w).$$

When $k > 0$, the series $\sum a_n$ is said to be summable (R, λ, k) to the sum s , if $\lim_{w \rightarrow \infty} C_{\lambda}^k(w) = s$, where $C_{\lambda}^k(w) = w^{-k} A_{\lambda}^k(w)$ is called the Riesz mean of order k and type λ . (Hardy and Riesz, *The General Theory of Dirichlet Series*, 1915).

The series $\sum a_n$ is said to be strongly summable (R, λ, k) with index q , or summable $[R, k, q]$ to sum s , where $k > 0$, $q \geq 1$ and $\lambda_n = n$, if

$$\int_x^{\infty} |w(d/dw) C_{\lambda}^k(w)|^q dw = o(x)$$

and $C_{\lambda}^k(w) \rightarrow s$, as $x \rightarrow \infty$ (Boyd and Hyslop, *Proc. Glasgow, Math. Assoc.*, 1952).

This non-linear method of strong Riesz summability depends on three parameters, the type n , the order k and the index q . Major portion of the work in this direction has been done by Pramila Srivastava. She has given two alternative definitions, one analogous to that of strong Cesàro summability due to Winn (*Math. Zeit.*, 1933) and the other corresponding to the above, for strong Riesz summability in general and has built up a general theory for this type of summability (*Abstract, Indian Sci. Cong. Assoc.*, 1955, and *Proc. Nat. Inst. Sci., India*, 1957). These definitions are :—

(i) If $\int_{\lambda_0}^x |C_{\lambda}^{k-1}(w) - s|^q dw = o(x)$, as $x \rightarrow \infty$, $k > 0$, $q > 0$, then $\sum a_n$ is said

to be strongly summable to sum s , by Riesz means of order k , type λ and index q , or simply summable $[R, \lambda, k, q]$, when $q=1$, $[R, \lambda, k, q]$ is written simply as $[R, \lambda, k]$.

(ii) If $\int_{\lambda_0}^x |w(d/dw) C_{\lambda}^k(w)|^q dw = o(x)$, as $x \rightarrow \infty$ and $C_{\lambda}^k(x) \rightarrow s$ then

$\sum a_n$ is said to be strongly summable to sum s , or simply summable $[R, \lambda, k, q]$ to the sum s , $k > 0$, $q \geq 1$.

Almost simultaneously definitions similar to (i) above have also been given by H. E. Richert (*Nach. Acad. Weissen Göttingen*, 1956) and later investigated by Glatfeld (*Proc. Glasgow Math. Assoc.*, 1957). Some of the Theorems given by Srivastava have also been proved by Glatfeld.

2. Pramila Srivastava has established a number of theorem (*ibid.*) showing inter-relations between the ordinary, strong and absolute Riesz summability of infinite series, between strong Riesz summability of different orders and different indices and between strong Riesz summability and strong logarithmic summability. She has established a number of theorems analogous to those for strong Cesàro summability.

She has established (*Indian Journal of Mathematics*, 1959) for strong Riesz summability a consistency theorem, which may be looked upon as a direct analogue

of a theorem of Hirst (PLMS, 1932) for ordinary Riesz summability. She has also proved (Communicated for publication) that if summability $[R, \lambda, k, q]$ of the series $\sum a_n$ is given, then the summability factor $\{\lambda_n^{-k}\}$ suffices to make the factored series $\sum a_n \lambda_n^{-k}$ summable $[R, 1, k, q]$, where $\lambda_n = e^{\lambda^n}$, as in the case of ordinary and absolute summabilities. When $k \geq 1$ and $q > 1$, she has proved more viz., that even the factor $\{\lambda_n^{-k-1+1/q}\}$ serves the purpose.

The following theorem of Srivastava includes as a particular case the corresponding convexity theorem for strong Cesàro summability given by Wiin (Math Zeit., 1933)—

Theorem—If $\sum a_n$ is summable (R, λ, k) , for some positive k , and is bounded $[R, \lambda, r]$ for some $r \geq 0$, then it is summable $[R, \lambda, r + \delta]$, whenever $\delta > 0$, (in course of publication in the Proc. Amer. Math. Soc.).

In a recent note, (Abstracts, Indian Sci. Cong. Assoc., 1960) she has extended this theorem to the case of strong Riesz summability, with an index $q > 1$, and has thus proved a theorem which includes the corresponding result for strong Cesàro summability due to Flett (PLMS, 1959).

3. G. D. DIKSHIT (Allahabad) : Riesz Summability Factors.

The results concerning the summability factors for Riesz summability of series seem to be of very late interest, though the first theorem in this direction was given as early as in 1915 by Hardy and Riesz. They proved that if for $k \geq 0$, $\sum a_n$ is summable (R, λ, k) then $\sum a_n (\lambda^{-k})_n$ will be summable $(R, \exp. (\lambda), k)$. Recently Guha (1956) has generalised this theorem by proving that if $\mu(x)$ be a logarithmico-exponential function such that for a $\delta > 0$, $1/x < \delta \mu'(x)/\mu(x)$, as $x \rightarrow \infty$ then for $k \geq 0$, the summability (R, λ, k) of a series $\sum a_n$ implies the summability $(R, \mu(\lambda), k)$ of the factored series $\sum a_n \gamma(\lambda_n)$ where $\gamma(x) = \{\mu(x)/x \mu'(x)\}^k$. For the integral order of summability, almost simultaneously, Borwein (1956) gave a general version of the above theorem. Borwein's theorem is more general than Guha's inasmuch as the 'type' of summability $\mu(\lambda)$ belongs to a general class of monotonic increasing functions.

With regard to absolute Riesz summability factors for general infinite series, it was only in 1950, that Mohanty gave the analogue of the theorem of Hardy and Riesz, mentioned above, in the special case $k=1$. The general case was disposed of by Tatchell in 1954. For the integral order of summability Guha (1956) also gave the analogue of his summability factor theorem for absolute summability. Generalising all these previous results, for the integral order of summability Dikshit (1958) proved the analogue of Borwein's result for absolute summability. The conditions imposed on the function $\mu(x)$, representing the 'type' and the function $\gamma(x)$, representing the 'summability factor' are much less stringent than those in the Borwein's theorem. Dikshit (paper to appear in Proc. Nat. Inst. Sci., India) has extended his theorem to the non-integral order of summability.

The Riesz summability of series is more or less identical with the Cesàro summability of Lebesgue-Stieltjes integrals. Concerning the summability factors of the integrals and Dirichlet series, recently a series of papers has been published by Bosanquet, Sargent, Cossar, Austin, Borwein and others. Starting with a condition on the order of the strong Riesz sum of $\sum a_n$, Pramilla Srivastava (1958) has considered the summability factors for $[R, \lambda, k]$ of $\sum a_n$.

Dealing with the logarithmico-exponential type of summability for a Fourier series Mohanty (1951) proved that if $\varphi(t) \in BV(0, \pi)$ then the series $\sum A_n(x)/\log(n+1)$ will be summable $[R, \exp.(\alpha), 1]$, $0 < \alpha < 1$. In 1954, Mohanty and Misra proved that if for $0 < \alpha < 1$, $\varphi_\alpha(t) \in BV(0, \pi)$, then $\sum A(x)/\log(n+1)$ is summable $[R, \exp.(\log w)^{1+\alpha}, 1]$. In this direction, quite recently Dikshit (Volume of Abstracts, current session of the Indian Science Congress) has proved a theorem on absolute Riesz summability factors of a Fourier series which includes as a particular case the previous results of Cheng (1948) and Sunouchi for $|C|$ -summability factors. Considering the absolute summability of order 1, Matsumoto (1956) proved some theorems for the logarithmico-exponential type of summability of a Fourier series with some Lebesgue set type of conditions on $\varphi(t)$. His results were subsequently generalised, as far as the summability factors were concerned, by Pramila Srivastava (1958). In a recent paper dealing with the absolute logarithmic summability Bhatt (Volume of Abstract, current session of the Indian Science Congress) has also generalised some of the results of Matsumoto.

4. (KUMARI) PRAMILA SRIVASTAVA (Allahabad): *Applications of Riesz Summability to Dirichlet's Series.*

It was as generalisations of the arithmetic means as well as the logarithmic means, especially adapted to the study of the general Dirichlet's series $(*) \sum a_n e^{-\lambda_n s}$, that the Riesz means were introduced (1909). Summability (R, λ, k) and summability $(R, 1, k)$, where $\lambda_n = e^{\lambda n}$, of the series $(*)$ have been termed as summability by typical means of the first kind and summability by typical means of the second kind respectively. Hardy and Riesz (1915) showed that if $\sum a_n$ is summable (R, λ, k) , then $(*)$ is uniformly summable (R, λ, k) throughout the angle α defined by $|\arg s| \leq \alpha < \pi/2$. This led to the existence of an abscissa σ_k called the abscissa of summability (R, λ, k) , with the property that the series $(*)$ is summable (R, λ, k) at all points to the right of the line $\sigma = \sigma_k$ and not summable (R, λ, k) at any point to the left of this line. Similarly the abscissa of summability $(R, 1, k)$ has been shown to exist. These two abscissae are, moreover, known to be equivalent and their common value has been evaluated in terms of the coefficients a_n .

In 1929, Obrechhoff introduced absolute Riesz summability and applied it to Dirichlet's series. Here, again, the abscissae of summabilities $|R, \lambda, k|$ and $|R, 1, k|$ have been evaluated. The equivalence of these two has been recently established by Tatchell (1954). The various relationships between the abscissae σ_k and g_k , where g_k denotes the abscissa of summability $|R, \lambda, k|$, obtained by Bosanquet (1947, 1948), Austin (1952) and Borwein (1955) are given by the following

$$(i) \sigma_k \geq g_{k+1} \geq \sigma_{k+1},$$

$$(ii) g_k + x \leq \sigma_k + (1-x)D, \quad k \geq 0, \quad 0 \leq x \leq 1,$$

where

$$D = \lim_{n \rightarrow \infty} \frac{\log n}{\log 1_n}$$

The notion of strong Riesz summability has been introduced for $\lambda_n = n$ by Boyd and Hyslop (1952) and for general λ_n by Richert (1956) and Srivastava (1957). When applied to Dirichlet's series, it is seen that the abscissae of summabilities $[R, \lambda, k, q]$ and $[R, 1, k, q]$ exist and are equivalent: and this

common abscissa includes as particular cases both the abscissae of ordinary and absolute summabilities, more precisely

$$\sigma_{k,q} = \sigma_{k-1}, \quad q = \infty$$

and

$$\sigma_{k,1} = g_k,$$

where $\sigma_{k,q}$ stands for the abscissa of summability $[R, \lambda, k, q]$. And this indicates that the properties concerning σ_k and g_k would follow from the corresponding more general results on $\sigma_{k,q}$.

The properties of σ_k considered as a function of k were first investigated by Bohr (1909, 1910) for ordinary Dirichlet's series. These were made more precise by Hardy and Littlewood (1912). And finally it was shown by Riesz (1923) that σ_k , evidently a decreasing function of k , is a convex function of k . The corresponding theorem for g_k also has been recently proved by Srivastava (1959). We have in fact proved more viz. that the abscissa $\sigma_{k,q}$ is a convex function of k and q . For the ordinary Dirichlet's series these have been obtained by Richert.

A limitation theorem involving the Riesz means of $\sum a_n$ and summability (R, λ, k) of (*) was given by Riesz (1918). Its analogue for absolute summability has been given by Bosanquet (1953) and Issacs (1953). And the corresponding result for strong summability also holds true.

Concerning the properties of the sum function $f(s)$ with reference to the summability of the corresponding Dirichlet's series we have (i) if the series (*) is summable (R, λ, k) for $s=s^*$, then uniformly, for $\sigma > \sigma^*$,

$$f(s) = O(|\tau|^{k+1}),$$

as $\tau \rightarrow \infty$, and (ii) if (*) is summable $|R, \lambda, k|$ for $s=s^*$, then for $\sigma > \sigma^*$

$$f(s) = O(|\tau|^k).$$

due respectively to Hardy and Riesz (1915) and Obrechhoff (1929).

There are other theorems concerning the summability (R, λ, k) and the summability $(R, 1, k)$ of the series (*) on the line of summability and also converse theorems on the abscissa of summability, Tauberian in nature, which have been discussed in detail by Chandrasekharan and Minakshisundaram (1952). The question of the existence of similar results for absolute and strong summabilities remains open.

As pointed out by Chandrasekharan and Minakshisundaram it is an interesting and important problem to determine the abscissae σ_k , g_k or $\sigma_{k,q}$ of the Dirichlet's product series $\sum c_n e^{-\lambda_n s}$ knowing those of its components $\sum a_n e^{-\lambda_n s}$ and $\sum b_n e^{-\mu_n s}$. When the Dirichlet's series involved are ordinary Dirichlet's series, Bohr (1950) proved for ordinary summability a theorem, the best of its kind, related with this problem. The present speaker has obtained a similar theorem for absolute summability also (in an unpublished paper).

5. S. N. BHATT (Allahabad) : *Tauberian Theorems.*

A theorem which asserts that if a series is summable (X), and satisfies some further conditions K_X (which will depend on the method (X)), then it is convergent, belongs to a class of theorems called *Tauberian* after A. Tauber, and the condition K_X is called the Tauberian condition. One of the early Tauberian theorems concerning Riesz summability is the following theorem due to Hardy—

If $a_n = \lambda_n / (\lambda_n - \lambda_{n-1})$ and if the series $\sum a_n$ is summable (R, λ, k) , $k > 0$, then $\sum a_n$ is convergent.

This theorem was subsequently extended and generalized by various authors including Hardy and Littlewood and Anand Rau. In a series of paper, Anand Rau gave different variants of the above theorem. Taking the condition on the terms of the given series slightly in a different form, Ganpati Iyer proved some results on Tauberian theorems in 1935. Subsequently Minakshisunderam extended the results of Anand Rau and Ganpati Iyer. O. Szasz proceeding on a different line gave rise to a new line of approach to the Tauberian theorems for Riesz summability. Making use of the difference formula introduced by Kloosterman, Bosanquet in 1943 extended the theorem of Anand Rau and also introduced some parameters in it. Later on Minakshisunderam and Rajgopal extended some of the previous results by introducing some general types of functions for order estimations in the conditions.

Concerning the absolute Riesz summability very few results are known on Tauberian theorems. The analogue of the Hardy's theorem has been given by Pati (Math. Zeit., 61 (1954), 75-78) in the following form—

If (i) $\{\lambda_n/\lambda_{n+1}\}$ is of bounded variation, (ii) $\left\{\frac{\lambda_n a_n}{\lambda_n - \lambda_{n+1}}\right\}$ is of bounded variation and (iii) the series $\sum a_n$ is summable $|R, \lambda, k|$, $k > 0$ then the series $\sum a_n$ is absolutely convergent.

For the particular case $k=1$, this theorem was given by Mohanty. Quite recently (Indian Journal of Mathematics, 1, 1959, 29-32) Bhatt has generalized the above theorem of Pati in the following form—

If the sequences λ_n/λ_{n+1} and $\left\{\frac{1}{\lambda_n} \sum_{\nu=1}^n a_\nu \lambda_\nu\right\}$ are of bounded variation and the series $\sum a_n$ is summable $|R, \lambda, k|$, $k > 0$, then the series $\sum a_n$ is absolutely convergent.

Taking the help of the Tauberian theorems for general infinite series, criteria for convergence of a Fourier series for its Riesz summability has been given by Wang. Recently Kanno has also deduced in the similar manner some convergence criteria for a Fourier series from its Riesz summability of Logarithmico-exponential type. The first result in this direction—from Riesz summability of a Fourier series to its Absolute convergence—has been deduced by Mohanty.

II. ADVANCE NOTES ON THE SYMPOSIUM ON NORMED LINEAR SPACES

Chairman : PROF. V. G. IYER, Annamalainagar.

1. M. VENKATARAMAN (Madras) : Normed Linear Spaces.

The normed linear space is a natural generalisation of ordinary Euclidean space and has been of considerable importance in analysis since most natural classes of functions constitute normed Vector Spaces. Thus it has been found enormously worthwhile to study "normed linear spaces"—abstractly defined as Vector Spaces endowed with a norm, satisfying $\|x+y\| \leq \|x\| + \|y\|$; $\|\lambda x\| \leq |\lambda| \cdot \|x\|$.

The basic patterns of progress follow lines typical of the study of other Mathematical structures—(a) to study various concrete spaces, more frequently met with, (b) consider various modes of constructing newer spaces out of known ones, (c) investigate the various natural classes or types of Normed spaces (cf. Subba Rao and Sundaresan), (d) attempt to characterise as completely as possible, some or any of these classes or concrete instances and (e) pass on to see whether this analysis could reveal more light or a better perspective of the more classical investigations. We shall report in some detail on some of these aspects.

This is the stage where one feels the need for (i) introducing some more structure or some more axioms and thus specialise the field of study to more special but richer cases e.g. the Normed Algebras (cf. Rajagopalan) or Banach spaces and or (ii) generalising slightly some of the axioms to the extent that a recognisably similar extension of the results and techniques could still be had—to more general Topological Vector Spaces (cf. Krishnamurti).

Typical among the problems met with in the finite dimensional case is that of linear functionals and linear transformations or operators, corresponding in a large measure to the study of the straight line or the plane; and of quadrics. The study of operators has, starting from the canonical form of $n \times n$ matrices, developed richly, particularly in Hilbert spaces. The case of operators (cf. Balachandran) in more general spaces and the study of Algebras of operators (cf. Rajagopalan) in Hilbert space have been receiving extensive attention in recent years.

With a normed Vector space V , concrete or abstract, we are able to associate other topologies, particularly the weak-topology in V or in the dual-space (proofs of the existence of which and whose relation to V lean heavily on the Hahn-Banach Theorem, cf. Ramachandran on Hahn-Banach Spaces). This has been a very useful technique and has bearings on probability (cf. Varadarajan) and the theory of distributions.

2. M. V. SUBBA RAO (Tirupathi) : *Uniform Convexity, and allied notions.*

We are concerned here with reviewing some notions associated essentially with the metric of a normed vector space (N.V.S.) and examine their inter-relationship.

Let x, y, x_n, y_n , ($n=1, 2, \dots$) be elements on the unit sphere of a N.V.S.E. E is said to be (1) strictly convex (S.C.) if $\|x+y\|=2$ implies $x=y$; (2) uniformly convex (U.C.) (Clarkson) if $\|x_n+y_n\| \rightarrow 2$ implies $\|x_n-y_n\| \rightarrow 0$; (3) Uniformly flat (U.F) (Day) if $\eta(\varepsilon) \rightarrow 0$ as $\varepsilon \rightarrow 0$ where

$$\eta(\varepsilon) = \sup_{\|x-y\| \leq \varepsilon} \left[\frac{2 - \|x+y\|}{\|x-y\|} \right]$$

(4) Uniformly even (U.E.) (Nakano) if for $\varepsilon, \varepsilon' > 0$ we can find a $\delta > 0$ such that $\|x\|, \|y\| \geq \varepsilon, \|x-y\| \leq \delta$ imply $\|x\| + \|y\| \leq \|x+y\| + \varepsilon\|x-y\|$

(5) Locally uniformly convex (L.U.C.) (Lovaglia) if $\|x+y_n\| \rightarrow 2$ as $n \rightarrow \infty$ implies $\|x-y_n\| \rightarrow 0$;

(6) Smooth (S.M) if at each point x , there is a unique hyperplane of support to the unit sphere (Kelly, and Arens).

It is known that $U.C. \rightarrow L.U.C. \rightarrow S.C.$ and that these are distinct notions. Further, E is U.C. (U.F) if and only if B^* , its dual is U.F. (U.C.). It is shown here that $U.E. \rightarrow U.F$ while the reverse is yet to be established. All the above properties hold in λ_p, L_p , ($p > 1$).

Further, it is known a U.C. (U.E.) Banach space is reflexive while there exist reflexive B -spaces not isomorphic to U.C. (U.E)-spaces; we also examine here the following weaker forms of U.C. :

(1) $\|x_n+y_n\| \rightarrow 2$, as $n \rightarrow \infty$ implies $f(x_n-y_n) \rightarrow 0$ for an assigned set of functionals, 'f'.

(2) For an assigned set of functionals 'f' $|f(x_n+y_n)| \rightarrow 2$, as $n \rightarrow \infty$ implies $\|x_n-y_n\| \rightarrow 0$ and compare these with notions already mentioned.

Finally, we state some of the unsolved problems and conjectures among which may be mentioned the following: A space is U.C. if and only if for some $p > 1$, $\|x+y\|^p + \|x-y\|^p \leq 2^p$. This is supported by all the known examples of U.C. spaces.

3. K. SUNDARESAN (Tirupathi) : Unit Sphere in Normed Vector Spaces.

A perusal of existing literature reveals that while sufficient attention has been paid to strict convexity, not much is known about non-strictly convex spaces. Most of the metric properties of the norm defined over a vector space E such as U. C, U. F. can be obtained by a study of the greatest lower bound (g.l.b) and least upper bound (l.u.b) of

$$\frac{\|x+y\|^p + \|x-y\|^p}{\|x\|^p + \|y\|^p} \text{ where } x, y \in E$$

In general this g.l.b. $= G_p(x, y) = 2^{1-\alpha}$ and l.u.b. $= L_p(x, y) = 2^{p^{-1}+\beta}$, where α, β lie in the closed interval $(0, 1)$. A systematic study of the $G_p(x, y)$ and $L_p(x, y)$ has given rise to the considerations of the following new notions:

1. Index of Flattening: A n.v.s. is said to have an index of Flattening 'i' if i is the l.u.b. of K 's for which $\eta_K(\epsilon) \rightarrow 0$, as $\epsilon \rightarrow 0$, where

$$\eta_K(\epsilon) = \sup_{\|x-y\| \leq \epsilon} \left[\frac{2 - \|x+y\|}{\|x-y\|^K} \right], \quad \|x\| = \|y\| = 1.$$

It follows that for every n.v.s. there exists an index lying between 1 and 2. The inner-product spaces are characterised by the index 2. For l_p, L_p ($1 \leq p \leq 2$)

$i=p$, while for $p > 2$, $i=q$ where $\frac{1}{p} + \frac{1}{q} = 1$.

2. In the other direction, if $L_p(x, y) = 2^p$ then either (1) there exist elements x, y on the unit sphere such that $\|x+y\| = 2 = \|x-y\|$ or (2) there exist sequences $(x_n), (y_n)$ such that $\|x_n + y_n\| \rightarrow 2$, and $\|x_n - y_n\| \rightarrow 2$, as $n \rightarrow \infty$. Normed spaces satisfying property 1, are called spaces of type S and the spaces of the other type are known as S_1 -spaces. We mention here the following properties of Type S or of Type S_1 .

1. Every n.v.s. of type S is not S.C. and not SM.

2. If B is of type S or S_1 then B^* is of type S or S_1 not necessarily in the same order.

If B is of type S and is weakly compact, then B^* is also of type S.

3. Every n.s.c. norm can be replaced by an equivalent S.C. norm (topological sense) in an infinite number of ways.

In conclusion, I wish to mention some problems which await solution:

(a) Are there S.C. spaces in which property S_1 holds?

(b) Are there SM spaces in which property S_1 holds?

4. R. RAMACHANDRAN (Vikram) : Banach Spaces With the Extension Property.

We propose to consider normed real vector spaces X with the following property: Any continuous linear function mapping an arbitrary normed vector space into X admits of a norm-preserving extension over any normed superspace of the domain. The Hahn-Banach theorem in fact states that the real space (i.e. the one dimensional normed vector space) has this property.

A remarkable and elegant simplification of this property is the following :— The normed real vector space has this property if and only if it admits a projection of norm one from every normed superspace of one more dimension.

A metamorphose of this property is the binary intersection property of the spheres. It is also possible to characterise the spaces possessing this property in terms of their bounded subsets.

An elegant concrete representation of such spaces is also known; namely as the space of all continuous real functionals defined over an extremely disconnected compact Hausdorff space.

It is found that these facts cannot straightway be applied to complex normed vector spaces.

5. V. K. BALACHANDRAN (Madras) : *The Problem of Unitary Equivalence for Operators in Hilbert space.*

It is well known that a normal $n \times n$ matrix A is unitarily similar to a diagonal matrix, the (diagonal) elements of D being the eigenvalues of A . A is determined upto unitary equivalence by D . Thus, the eigenvalues with their associated multiplicities form a set of unitary invariants for a normal (linear) operator in a finite dimensional Hilbert space. Further, the diagonal form D gives a canonical representation for the normal operator A . The general problem is to seek such unitary invariants and canonical representation for normal operators in an infinite dimensional Hilbert space.

In this talk we first consider briefly the solutions in this problem given by Hellinger, Hahn, Stone, Wecken, Nakano and Halmos. We then report in a somewhat more detailed manner, the recent contribution to the subject made by Venkataraman and independently by Varadaraju. Finally, we conclude with some remarks on Bade's multiplicity theory for algebras of spectral operators in a Banach space.

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6. M. RAJAGOPALAN (Benares) : *Normed Algebras.*

In this talk, I touch on the work of various authors—Gelfond, Neumark, Segal, Ambrose, Kaplansky and Von Neumann on a variety of normed Algebras.

The fundamental problems is to characterise the structures of a wide class of Banach Algebras—which are basically Banach spaces endowed with a "multiplication", compatible with the operations of the Banach Space.

The complex case has been studied to a much greater degree of thoroughness than the real case. Naturally here, the algebra is supposed to be endowed with an involutoric operation* corresponding to conjugation. The earliest of the results to be obtained is that of Gelfond who shows that such commutative algebras (with a unit element) are precisely those which are isomorphic to the Algebra of all complex-valued continuous functions defined over a compact space Γ . The result has been suitably extended to cover the case without unit element, corresponding to the locally compact space Γ .

Other important classes of Algebras that have been studied are the Hilbert Algebras, the C^* Algebras, and the Von-Neumann or the W^* Algebras. Important concrete representations of these are the total matrix Algebra and the Algebra of bounded operators in a Hilbert Space. A class of pseudo* Algebras—the unitary rings of Godement—characterising the structure of the class of functions of $L_2(a, b)$ have also been studied by the author and Prof. Meenakshisundaram.

7. V. KRISHNAMURTI (Annamalai) : *Linear Topological Spaces.*

It is the purpose of this talk to exhibit how far certain important theorems and properties connected with Normed Linear Spaces are valid in the more general setting of a Linear Topological Space. We study, in particular, the following :

1. Hahn-Banach Theorem—its largest range of validity being the locally convex linear topological spaces;
2. The property of a Mackey Space, that the finest topology for which E' continues to be the topological dual of a locally convex linear topological space E is the initial topology of E ;
3. Banach-Steinhaus Theorem—which holds in general Barrelled Spaces, defined by the internal property, that every barrel is a neighbourhood of zero;
4. Closed Graph Theorem and the Open Mapping Theorem—which are valid in general F -spaces and can be extended to what are called Fully Complete spaces;
5. Reflexivity of Montel spaces—which possess the property that every bounded closed set is compact, a property not shared by infinite dimensional normed linear spaces;
6. Fredholm Alternative Theorem—which can be proved even in general locally convex linear topological spaces, with slight modification; and
7. General Theorems about the range and inverse of a continuous linear operator and its adjoint.

8. V. S. VARADARAJAN (Calcutta) : *Weak topologies on spaces of measures.*

The main purpose of these remarks is to discuss a few problems associated with the weak topologies on certain normed linear spaces of measures. It must be mentioned that the motivation for these problems comes from the theory of Probability even though the problems themselves seem to have independent interest.

In these problems interest centres round a topological space X , the space $C(X)$ of functions bounded and continuous on X , and the dual $M(X)$ of $C(X)$. By virtue of fundamental theorems on representation of linear functionals, every element of $M(X)$ can be identified with a regular, finitely additive signed measure on X . The principal object is to study the weak topology on $M(X)$ and its subsets : $M_+(X)$ —the subset of positive elements, $M_\sigma^+(X)$ —the subset of countably additive positive elements and $M_\tau^+(X)$ —the set of countably additive positive elements satisfying a far-reaching continuity restriction. Among the many results

may be mentioned those of Prohorov (1956) and the author (1958) which completely settle the problem of characterization of $M_{\tau}^{+}(X)$. The natural problem of characterizing compact subsets of $M_{\sigma}^{+}(X)$ can also be given reasonably satisfactory answers (Lecam (1957) and the author (1958)). It is interesting to note also that the topological structure of a completely regular Hausdorff X is completely determined by the norm and weak topological structures on $M(X)$. These problems and the techniques associated with them lead to comprehensive applications in the theory of stochastic processes (Kolmogorov and Prohorov (1954), Prohorov (1956), Skorohod (1957) and (1958)).

When X carries a group of structure compatible with its topology, further problems arise. In this case we can equip $M(X)$ with a natural multiplication (convolution), and the study of $M(X)$ as a topological algebra is a major problem awaiting solution. The results so far obtained can hardly be considered decisive. The most penetrating results have only been obtained for the case of a finite dimensional vector space X (see Gnedenko and Kolmogorov (1949) for a complete exposition). The general situation, where X is, on the one hand a locally compact abelian group, and on the other hand, an infinite dimensional topological vector space, is still obscure.

III. ADVANCE NOTES ON THE SYMPOSIUM ON FLUID DYNAMICS

Chairman : PROF. V. G. IYER, Annamalaiagar.

1. J. N. KAPUR (Delhi) : "*The Effects of a small steady disturbance in a compressible fluid.*"

Fluid Dynamics of viscous, compressible and heat-conducting fluids presents considerable difficulties and solutions can be obtained only under rather restrictive assumptions, though the solutions are valuable for getting an insight into the effects of viscosity, compressibility and heat conductivity when these are simultaneously present. The author has recently examined the following problems in this field :

- (i) Transverse component of velocity in a plane symmetrical jet of a compressible viscous fluid [Quart. Journ. Mech. App. Math., XI, 1958, pages 423-426].
- (ii) Steady compressible viscous fluid through a circular pipe (Proc. Third Cong. Th. App. Mech., III, 1959, pages 243-250).
- (iii) Transverse component of velocity in a plane symmetrical forced jet of a compressible fluid [Bull. Cal. Math. Soc., Vol. 51, 1959, pages 34-38].
- (iv) Flow of a viscous compressible fluid round a corner [Mathematics Student, 1959].

Another important problem in this field is the discussion of the effects of small disturbances in the flow of a compressible viscous and heat-conducting fluid. The problem was first studied by Ray [Bull. Cal. Math. Soc., Vol. 45, 1953, page 45] where he found that (i) variation of temperature is proportional to velocity, (ii) disturbance effects depend on only one parameter viz. Prandtl number, (iii) there is no generation of heat by dissipation. The assumptions he made were (a) pressure of the steam does not change on account of the disturbance, (b) direction of the velocity also does not change on this account, (c) $\mu \frac{\delta u}{\delta x}$, $\mu \frac{\delta u}{\delta y}$ are proportional to the velocity, (d) the disturbance in the enthalpy is a function of velocity alone. It was pointed out by the author to Prof. Ray that (c) leads to a contradiction. Prof. Ray has removed the contradiction in a recent paper [Bull.

Cal. Math. Soc., Vol. 50, 1958, pages 150-154], but the results would be consistent with (a) and (d) only for extremely small disturbances. In the present paper, all the assumptions and conclusions have been examined and a new special solution is given. The solution which is exact is valid for Prandtl number .75. This is of practical interest as, for air, Prandtl number is in the neighbourhood of this value.

2. RAM BALLABH (Lucknow): *Superposable axially symmetric flows.*

In the year 1940 I derived the general conditions under which one fluid motion can be superimposed on another such that the velocity of the resulting flow is the vector sum of the velocities of separate flows. The present paper aims at studying a class of unsteady superposable flows for which the boundary is a tube of circular section.

It is remarked that Sneddon's* problem of diffusion of heat in an infinitely long cylinder of given radius when there are sources of heat within it which lead to an axially symmetrical temperature distribution can be solved more easily by the method of superposition.

3. Y. D. WADHWA (Kharagpur); *Unsteady stagnation flow towards a rotating Lamina.*

One of the few exact solutions of the Navier Stokes' equations furnishes the flow of a viscous incompressible fluid caused by the uniform rotation of a flat plate. The solution of the problem was first obtained by Karman (1921, ZAMM., p. 244). Cochrane (1934, Proc. Camb. Phil. Soc., 30, p. 365) pointed out some errors in Karman's solution and gave the modified solution. The unsteady case of motion when the plate is started impulsively was considered by Thiriot [1940, ZAMM., 20, p. 1] using a rotating system of coordinates. The same problem was solved by Nigam (1951, Qly. Appl. Math., 9, p. 89] using a fixed system or coordinates. The general case when the velocity of the plate varies as t^λ ($\lambda \geq 0$) has recently been discussed by the author [Forthcoming publication in Proc. 4th Cong. Theo. Appl. Mechs. (India)]. Bodewadt (1940, ZAMM., 20, p. 241) considered the allied problem when the plate is stationary while the fluid rotates uniformly at infinity.

Recently, attempts have been made to introduce some more parameters into the problem. Batchelor (1951, Qly. J. Mech. Appl. Math., 4, p. 29) and Stewartson (1953, Proc. Camb. Phil. Soc., 49, p. 333) discussed the flow between two rotating discs or the flow due to a rotating disc with liquid rotating at infinity. Millsaps and Pohlhausen (1952, J. Aero. Sci., p. 120) considered the heat transfer effects on the flow due to a rotating disc. The steady rotation of the plate with suction has been investigated by Stuart (1954, Qly. J. Math. Appl. Mech., 7, p. 446). The flow with suction due to a stationary plate with liquid rotating at infinity has been studied by Nanda (unpublished). Hannah (1952, Arc. Tech. Rep. R and M No. 2772 (104821) has obtained an exact solution of the Navier Stokes' equations for the flow due to a rotating disc with a forced flow at infinity towards the centre of rotation of the plate. Schlichting and Truckenbrodt (1952, ZAMM., 32, p. 97) have applied the Karman-Pohlhausen method to investigate the same problem. The case when the stagnation velocity U_∞ and the velocity of rotation V_∞ of the plate are of the form $a r (\Omega t)^n$ and $r_\infty (\Omega t)^m$ respectively forms the subject matter of the present investigation. The previous paper of the author (1959) becomes a special case of the present one for $k = \frac{a}{\Omega} = 0$. It is found that the solution of the present problem necessitates a relation between n and m of the type $n=m$ or $n=2m+1$. For $K=0$ the two cases become identical.

* Sneddon, I. N., Fourier Transforms, 1951, p. 204.

The equations of motion are expressed in a suitable dimensionless form. Using a similarity parameter the solution is developed in series for the velocity components in ascending powers of time. The analytical expressions for the functional coefficients are obtained up to the second term for the case of impulsive start and uniform acceleration.

4. DEVI SINGH (Lucknow) : *Superposable Flows of the types $\text{curl } q_1 = \lambda_2 q_2$ and $\text{curl } q_2 = \lambda_1 q_1$.*

In 1940, Ram Ballabh defined superposability of two fluid motions and deduced two particular solutions which symbolically can be written as

$$(1) \text{Curl } q_1 = \lambda_1 q_1, \text{Curl } q_2 = \lambda_2 q_2$$

$$(2) \text{Curl } q_1 = \lambda_2 q_2, \text{Curl } q_2 = \lambda_1 q_1$$

In the first case the vortex lines of the flows coincide with their own stream lines. In the second case the vortex lines of each flow coincide with the stream lines of the other.

Ballabh (Proc. Nat. Acad. Sci., 13A (1943)) discussed the second type of flows and obtained certain results by taking λ_1 and λ_2 both independent of space and time variables. Ghildyal (Proc. Nat. Acad. Sci., 26A (1957)) proved that uniplaner superposable flows of this type (where λ_1 and λ_2 are assumed to be independent of space variables) exist only if λ_1, λ_2 are absolute constants.

In the present paper it has been proved that in homogeneous incompressible fluids of $\lambda_1 = \frac{\lambda_2}{\alpha}$ where $\alpha = \int \lambda_2 dz$, and λ_1, λ_2 may be function of z and t alone. The following two sets of values have been obtained :

$$(i) \lambda_1 = \frac{2kze^{-kz^2}}{f(t)}, \lambda_2 = 2kze^{kz^2} f(t)$$

$$(ii) \lambda_1 = \frac{k'e^{-k'z}}{f(t)}, \lambda_2 = k'e^{k'z} f(t)$$

where $f(t)$ satisfies a certain differential equation and z is finite. If the flow is viscous and $\lambda_1 = k^2 \lambda_2$ where K is a function of t alone, λ_1 and λ_2 cannot be functions of z and t alone. In the case of non-viscous flow under the latter assumption, it has been shown that λ_1 and λ_2 can be expressed in the form $\lambda_1 = K F(z)$ and $\lambda_2 = \frac{1}{K} F(z)$.

5. NANDA R. S. (Kharagpur) : *Unsteady circulatory Flow about a circular cylinder with suction.*

An exact solution of the Navier-Stokes equations for the steady flow due to a rotating cylinder with uniformly distributed suction applied at the surface has been given by Preston [1950, Aero. Qly., 1, p. 319]. He has considered two separate cases :

(i) The cylinder rotating and zero circulation at infinity and (ii) the cylinder rotating and a constant circulation at infinity. He has shown that in the former case solution can be obtained only when the cross flow Reynolds' number (R) is greater than two, while in the latter case no restriction is placed on the value of R . It may be argued that in the former case suction such that $R/\sqrt{2}$ may not be sufficient to arrest the diffusion of vorticity outwards.

In the present paper we have considered the corresponding unsteady cases. Exact solutions of the Navier-Stokes equations have been obtained which tend

to the steady state as $t \rightarrow \infty$. Graphs have been drawn showing how the steady state is reached. It is found that steadiness spreads from infinity towards the cylinder. Such a flow may be generated by applying suction to the cylinder at rest and then giving it an impulsive twist such that it starts rotating with a uniform angular velocity.

Unsteady flow through a concentric annulus has also been considered, when one of the cylinders starts rotating with a uniform angular velocity while the other is kept fixed. It has been assumed that the rate of suction at one cylinder is equal to the rate of injection at the other. The solution consists of a steady part and a transient part which dies out as $t \rightarrow \infty$ when the so called Coaette flow with suction is established.

6. SRIVASTAVA, A. C. (Kharagpur) : *Rotatory oscillation of an infinite disc in non-Newtonian fluids in presence of a stationary disc.*

The equation of motion of an incompressible non-Newtonian fluid, when an infinite disc performs rotatory oscillation (about an axis perpendicular to its plane) in presence of an infinite parallel disc, have been approximately solved. The effect of cross-viscosity is to increase the amplitude of the oscillation of the normal force on the stationary disc while the frictional moment on the stationary disc is not affected. The normal force on the non-rotating disc varies inversely as the square of the distance between them and the frictional moment on the stationary disc varies inversely as the distance between them.

7. GUPTA, A. S. (Kharagpur) : *Flow of an electrically conducting fluid near an accelerated plate in the presence of a magnetic fluid.*

The Magnetohydrodynamics of the flow of a viscous, incompressible and electrically conducting fluid in the presence of an external magnetic field due to the impulsive motion of an infinite flat plate has been discussed by Rossow (1957, V.J., NACA TN., 3971). Recently Ong and Nicholls (1959, J. Aero/Space Sci., 26, p. 313) have extended the problem to cover the case of the flow near an infinite wall which executes simple harmonic motion parallel to itself. In both the problems, however, the induced magnetic field produced by the current has been neglected. Kakutani (1958, J. Phys. Soc. Jap., 13, p. 1504) has included this induced field while considering the flow of a hydromagnetic fluid in the presence of an oscillating flat plate.

In this paper the flow of an electrically conducting viscous incompressible fluid due to the accelerated motion of an infinite flat plate in the presence of a uniform magnetic field is discussed. The induced magnetic field is neglected as in the case of previous workers. The velocity profile is found in the case when the magnetic lines of force are fixed relative to the fluid and finally the skin friction is calculated.

8. JAIN, R. K. and J. N. Kapur (Delhi) : *On the stability of a simple solution of Magneto-hydrodynamics.*

The problem of discussing stability of different field configurations in the presence or absence of fluid motions is quite important in the study of self-excited fluid dynamos. There are two methods of studying static stability problems, either by energy principle or by infinitesimal perturbation method. Dynamical stability problems are, however, studied exclusively by infinitesimal perturbation method as that is the only effective method known so far. The stability of simple configurations about the stationary state solution has recently been studied by

several authors like P. H. Roberts [1956, Ap.J. 124, p. 430], S. K. Trehan [1958, Ap.J. 127, p. 446, 454, 1959, Ap., 129, p. 475] and W. H. Reir 1958, (Ap.J. 127, p. 454].

P. H. Roberts (1956) discussed the stability of twisted magnetic fields $\bar{H} = H [0, \frac{r}{p}, 1]$, (r, θ, z) will be taken throughout as the cylindrical coordinates of a point, $2\pi p$ is the pitch of the helixes formed on the surface of the cylinder) imbedded in an infinite, static, incompressible and inviscid fluid of infinite electrical conductivity, by small perturbation method. The model has been found to be unstable for certain modes of oscillation. Chandrasekhar (1956, Proc. Nat. Acad. Sci. U.S.A., 42, p. 273) (referred hereafter as paper I) proved the stability of a simplest solution of magnetohydrodynamics viz.

$$\bar{V} = \frac{\bar{H}}{(4\pi\rho)^{\frac{1}{2}}} \dots \dots \dots (1)$$

Chandrasekhar's result is surprising in the sense that an unstable field configuration like in Roberts model with internal fluid motions given by (1) becomes stable. Trehan (1958) (referred hereafter as paper II) attempted to find the cause of stability. He discussed it in the case of a simple field configuration $H = \bar{H} (0, \frac{r}{p}, 1)$ with internal fluid motions given by (1) and with a limiting form of boundary condition. The cause of stability from physical considerations is discussed. Here, the mathematical treatment is inconsistent and the conclusion drawn is not correct. In 1959, Trehan established a more general result that the system

$$\bar{V} = \frac{\alpha H}{(4\pi\rho)^{\frac{1}{2}}} (0, \frac{r}{p}, 1) \quad (\alpha = \text{const.})$$

is stable when the energy in the velocity field is greater than or equal to that in the magnetic field, otherwise there always exist modes of oscillation for which the system is unstable.

One more point about these papers, to be noted, is that the boundary condition assumed by Chandrasekhar (1956) and Trehan (1958) are essentially different. While former assumes the equality of the perturbations in velocity and magnetic field at the boundary, the latter has chosen continuity of total pressure (hydrodynamic and magnetic) as his boundary condition.

The object of this paper is three-fold. Firstly we shall examine the stability of a more general system.

$$\bar{V} = \frac{\alpha(r) H}{(4\pi\rho)^{\frac{1}{2}}} [0, g(r), f(r)]$$

by a method similar to that of Chandrasekhar (1956) and with the total pressure being taken as continuous at the boundary. A necessary and sufficient condition has been obtained for σ to be real in the integral form together with an integral relation for the perturbed system. Several particular cases including Trehan's (1958) and 1959 problems have been deduced from above.

Secondly, the boundary condition, in the above system has been changed to the vanishing of the perturbations in the velocity field and magnetic field at the boundary. Paper I is shown as a particular case. Stability of another simplest solution of magnetohydrodynamics viz.

$$\bar{V} = -\frac{\bar{H}}{(4\pi\rho)^{\frac{1}{2}}}$$

mentioned by Chandrasekhar (1956) has also been obtained as a particular case.

Lastly, the result of paper I has been properly interpreted and under this interpretation, the results of paper II are shown to be consistent.

9. R. MANOHAR (Chandigarh) : *Some Recent Contributions to the Methods of Integration of Prandtl's Boundary Layer Equations.*

Although Prandtl's boundary layer assumptions have simplified the Navier-Stokes equations considerably, the solution of the resulting boundary value problem in most cases of practical interest is troublesome. Only in some special cases, direct integration or a series solution may give satisfactory results. The methods of solving these equations in general can be divided into two classes, (I) the methods which give only approximate solutions and (II) those which can give exact solutions.

Well known amongst the approximate methods is that of Karman and Pohlhausen and its modified forms. However, these methods do not generally give satisfactory and reliable results. Recently another method known as 'wedge method' has been used by various authors. The method is based upon well known solutions of the wedge-shape profiles and hence the name. Some arbitrary hypothesis of physical nature is introduced in order to find the wedge element 'equivalent' to the element of profile considered. Meksyn has developed another method which may also be considered as a wedge method. The boundary layer equations are at first suitably transformed and certain mathematical simplifications introduced. The solution is then expressed as an integral, which is evaluated by method of steepest descent. The divergent expressions are summed using Eulers transformations. The calculations are simple and the results compare well with those obtained by lengthy and exact methods. Recently, Merk (1959) has used Meksyn's method are concerned.

When the accuracy desired is of a high order, exact methods are applied. Well known amongst the exact methods are the method of expansion in series and the method of finite differences. Gortler (1957) has given a new series, which is an improvement on all the previous attempts in this direction. The boundary layer equations are transformed by introducing suitable variables so that the first term in the new series satisfies the boundary conditions at the outer edge of the boundary. The higher order terms then appear as correction in the interior of the boundary layer. The coefficient functions are universal and can be tabulated once for all. Because of the poor convergence of the series, particularly when the separation of the flow occurs, the method can not be applied. Methods of finite differences are laborious without an electronic computer, but any desired accuracy can be attained with little extra effort. The characteristic difference method used by Grohne and Manohar (1958) has shown that reliable results can be obtained up to points close to separation, however it seems that no difference method can be applied to find the solution at the point of separation. The error can be estimated at every stage and the method is numerically stable.

10. S. NAGARAJAN (Bombay) : *Hydro Magnetic Turbulence.*

A rederivation of Chandrasekhar's elementary theory of hydromagnetic turbulence (Chandrasekhar, Proc. Eng. Soc. 1955) is given, which makes the physical implications of his extension, to hydromagnetics, of Heisenberg's ideas clear. The cascade equations are reduced to two equivalent differential equations, for the case of finite viscosity and resistivity. A Perturbation procedure is employed to prove that one of Chandrasekhar's solutions, the velocity mode becomes unacceptable, for the case of finite viscosity and resistivity. The interesting result which follows is the non-existence of a stationary non-magnetic solution of the equations, in a highly conducting fluid. This is viewed critically, comparing it with other theories.

11. S. K. SHARMA (Kharagpur) : "Flow of a Visco-Elastic liquid near a stagnation point."

The problem of ordinary viscous flow near a stagnation point was solved exactly by Froessling [Schlichting, Boundary layer theory, pp. 73-75]. In the present paper the problem of flow of a visco-elastic liquid near a stagnation point has been discussed. It is shown that the effect of elasticity depends on a non-dimensional parameter ϵa where a is constant of dimensions T^{-1} and is connected with potential flow. The present investigation enables the determination of boundary layer thickness and other quantities under different potential flow conditions in case the fluid is a solution of a highly polymerised methyle methacrylate in certain organic liquids for which a simple shearing motion can be represented by a stress-strain law of the form

$$t_{ij} + \tau \frac{d}{dt} t_{ij} = 2\mu (d_{ij} + \epsilon \frac{d}{dt} d_{ij})$$

where t_{ij} and d_{ij} are the extra-stress and rate of deformation tensors and τ and ϵ are the relaxation and retardation time constants of the fluid respectively and μ is the coefficient of viscosity.

12. AJIT KUMAR ROY (Bangalore) : *Critical Viscous Sub-layer.*

The classical theory of Boundary-Layer due to Prandtl tells us that the viscous effect of the fluid is solely confined within the boundary layer whereas the flow outside it is a potential one. Since then, this idea has been universally adopted in finding the solution of many viscous flow problems. But there exists a separate class of viscous flow problems where the consideration of the whole of the boundary layer thickness for the sake of the viscous effects is not absolutely essential. On the other hand, it has been shown that the viscous effects are confined within a fraction of the total boundary layer thickness, which has been termed by the present author as the critical viscous sub-layer. The flow outside that layer may be irrotational or partly rotational and partly irrotational but remains completely uninfluenced by viscosity. It is true that the potential flow outside the boundary layer influences the flow inside the boundary layer which in turn determines the thickness of the critical viscous layer. The thickness of the critical viscous sub-layer as well as the velocity of flow in that sub-layer have been estimated by the present author in the incompressible boundary layer flow problem (Roy, 1956) and in compressible (Shock-boundary-layer-interaction) problems (Roy, 1959). It is found that the thickness of the critical viscous sub-layer is very small and lies within the laminar sub-layer of the usual boundary layer flow in the turbulent case. Based on this concept of critical viscous sub-layer, the analytical formulations derived in the different cases, remain valid both in laminar and turbulent cases, compressible and incompressible flows. This is also physically understandable because the velocity in this sub-layer remains small enough for the compressibility effects to be neglected and the velocity distribution there can be assumed to be linear. Extending this concept of critical viscous sub-layer, in the heat-transfer problems in compressible flows, a formulation for the determination of the skin-friction with the help of the heat transfer from a heated element embedded on an insulated surface can be developed. A single calibration in the high speed tunnel, giving the heat loss of the heated element in terms of the shearing stress on the surface is found to hold (cf. Roy and Purusatham) for laminar and turbulent (compressible) boundary layers.

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I. ESTIMATION PROBLEMS IN ECONOMETRICS

Section of Statistics

Chairman : C. R. RAO, Calcutta.

Initiating the discussion, Dr. N. V. A. Narasimham (New Delhi) said that any given economic phenomenon is determined by (1) a set of variables which act simultaneously and which the analytical economist classifies, for the purpose of his explanation, into *endogenous* and predetermined ones and (2) a set of structural parameters which are considered to be the permanent characteristics of the phenomenon. The problems to be solved for the estimation of the structural parameters are four :

(i) *Specification* of the mathematical form in which the variables act; which depends generally on the short-period or long period changes of the economic phenomenon that the economist intends to explain.

(ii) *Screening* of variables to be included in each equation in order to reduce the risk of unacceptable results considerably. This requires generally testing of alternative economic hypotheses with the help of multiple correlation analysis. The general criteria for acceptability of a set of variables for inclusion in a particular equation are economic plausibility and consistency with actual observations made on the phenomenon.

(iii) *Identifiability* of each equation of the model, before applying the methods of statistical estimation. This requires, in the case of a linear model, a necessary but not sufficient condition, viz., that the number of variables included in each equation of the model should not exceed the number of predetermined variables in the model plus one.

(iv) *Simultaneous estimation* of parameters, owing to the fact that at any time, more than one relation exist among the variables. Such estimation should necessarily take into account the random disturbances present in the equations of the model. In certain cases, the structural parameters can be estimated by the method of least squares to get nearly the same results as by the method of simultaneous estimation.

Speaking next, Dr. N. S. R. Sastry (Bombay) said that the efficacy of any constructed econometric model is judged by its ability to predict. Least squares method of estimation is often found to be good for prediction. However, since the

predictions with econometric models are not always successful, the mathematical statisticians should investigate the validity of the various assumptions made in statistical estimation of structural parameters.

The following participated in the discussion :

Dr. Basu (Calcutta) : Does the specification of linear relationships among the economic variables, generally done by econometricians like Tinbergen, hold good for describing the complex economic reality?

Dr. Narasimham : Linear relationships among variables are found, by experience, to represent fairly well, the short-period changes in the economic system. For representing the long-period changes, different types of non-linear equations are used. So a linear system of equations can generally represent the short-term economic reality only.

Dr. Basu : In the method of simultaneous estimation of parameters, the errors in the relations are only considered; but not the errors in the observations on each variable included in the equation.

Dr. Narasimham : Errors in the variables are no doubt important. But it is generally found that the neglect of errors in the relations is more serious than the errors in the variables.

Dr. Basu : Referring to Dr. Sastry's remark on the usefulness of current econometric models for prediction, is not an econometric model, even if it cannot predict well, still useful for quantitative analysis of economic problems with the help of the variables and the coefficients in the model?

Dr. Narasimham : Even for analytical purposes, we must be sure that the given econometric model has sufficiently represented the econometric phenomenon in question. For this, the acid test is the ability of the model to predict.

Dr. Patankar (Bombay) : Referring to the method of statistical estimation, what is the difference if we take for estimation, the changes in the variables instead of the absolute values of the variables?

Dr. Narasimham : The variate difference method, developed by Tintner is certainly superior in that it gives more stable coefficients, although, it is found that the total correlations found by this method are generally lower than those given when absolute values of variables are used. For instance, we may estimate the coefficients in an equation, using the absolute values of the variables and the coefficients may be confirmed after employing the variate difference method also.

Prof. P. K. Bose (Calcutta University), at the conclusion of the discussion, discussed with Dr. Narasimham the possibility of using 'clusters' of variables in the process of screening variables for inclusion in any particular structural equation.

Dr. Narasimham : Given a linear model with n endogenous and m pre-determined variables, and also that any particular structural equation of the model should have, for just identifiability, a set of $m+1$ variables (endogenous and pre-determined put together), then there will be as many as $\frac{n+m}{m+1} \frac{n-1}{n-1}$ alternative

sets available for choice for inclusion in the equation. A knowledge of the principles of economic behaviour would, however, help us to exclude a number of alternative sets. But still the problem is there : which set of $m+1$ variables out of the economically plausible variables should be included in that equation? At this stage, grouping of the plausible variables into a few 'clusters' would prove useful for statistical testing of alternative economic hypotheses. But the problems to be faced are : (1) How to form such groups or 'clusters' of economically plausible variables? (2) How many clusters should be formed? (3) Should we include in an equation all the 'clusters' treating each cluster as a single variable, or shall we take one variable from each cluster at a time for inclusion in the equation? This is really a field in econometrics, where very little work has been done so far. Any further work in this direction would be of immense help to the econometric model builders.

I. MOOS CENTENARY SYMPOSIUM ON "SOLAR ACTIVITY AND ASSOCIATED GEOPHYSICAL PHENOMENA"

Section of Physics

President : DR. S. PARTHASARATHY, Delhi.

1. M. KRISHNAMURTHI, G. SIVARAMA SASTRY and T. SESHAGIRI RAO (Hyderabad) : *Solar Flares and Sudden Cosmic Noise Absorption.*

Among the effects of solar flares of interest to Radio Astronomy at metre wavelengths, one has to consider not only the great enhancement of energy received from the sun but also the sudden increases in cosmic noise absorption by the ionosphere. These latter are now attributed to the great increases in ionization at the lower levels of the ionosphere due to increased penetration of ionising radiation from the sun at the time of solar flares. The present note gives briefly some of the conclusions of a study carried out during the year 1958 by the authors on solar flares of importance 3+, 3 or 3- and associated effects on radio noise observations at 10 m wavelengths. Out of 40 such flares reported during the year by various observatories round the world, ten occurred when the sun was either in the other hemisphere or was otherwise completely out of the beam of the aerial array. Five flares could not be observed due to instrumental failure, rain or other local interference. Out of the remaining 25 solar flares, 21 have produced associated radio noise features giving an 84 per cent correlation between the flares and related radio noise phenomena. This compares well with 90 per cent reported by Dobson. Of particular interest are 9 occasions when Sudden Cosmic Noise Absorption (SCNA) was observed. It is now recognised that this is peculiar to wavelengths of the order of 10 m and longer. It is now proposed to give some features of these SCNA's.

- (i) The SCNA's have the characteristic feature of a solar flare namely of sudden commencement and gradual tapering off of the absorption.
- (ii) The times of start and end of each SCNA are in fair agreement with the corresponding solar flare times. The time of maximum SCNA exactly coincides with the maximum phase of the solar flare.
- (iii) An interesting feature is the occurrence of a number of short duration outbursts during the period of absorption. The series of outbursts is always headed by a major event lasting 3 to 5 minutes and occurring simultaneously with the maximum phase of the SCNA.
- (iv) The amount of absorption is generally found to depend on the zenith angle of the sun and the maximum absorption has varied between 1.2 db. and 7.5 db. depending on the intensity of the solar flare.
- (v) On all the nine occasions, corresponding short wave radio fadeouts and magnetic storms have been reported.

2. S. N. MITRA and S. C. BOSE (New Delhi) : *'Systematic Flare Patrol Through Longwaves'.*

It is known that on longwave propagation through the D layer of the ionosphere, the received sky-wave signal is intensified during the occurrence of a Solar Flare. This is because the reflection co-efficient of the D layer increases when intense radiation (ultra violet and X-rays) is incident on the ionosphere from an active flare region. An experimental investigation on the longwave propagation of a distant broad-casting station (Tashkent, frequency-164 Kc/s) was initiated at the Research Department of All-India Radio and the received signal was recorded continuously throughout twentyfour hours. These records indicated that there is always a sudden increase in the longwave signal (SIL) whenever a visible

flare is reported from Astronomical Observatories. Data for the period August to December, 1958 have been analysed and 144 instances of sudden increases observed during the period. A correlation of this SIL with the flare data collected from all Astronomical Observations in the world has indicated that flares of all classes (1, 1+, 2, 2+, 3, 3+) have given rise to sudden increase in amplitude of the long-wave signal. The times of beginning and maximum of these two events agreed within 5 minutes. The variation of $H\alpha$ line width during a flare is also well-correlated, in some instances, with the change in the amplitude of the corresponding SIL. The height of reflection of this obliquely incident longwave station is determined from the sun-rise effect and is 65 kms. The usefulness of an SIL in flare patrol and in the short term forecasting of sudden ionospheric disturbance is discussed in the paper.

3. Miss K. A. SARODA : *Flare patrol with Cosmic Radio Noise.*

A cosmic noise equipment working at 22.4 Mc/s and later at 30 Mc/s has been used to "observe" solar flares. Several major flares occurring during 1957 and 1958 are described. A good number of them coincide either with optical flares or with some other form of sudden ionospheric disturbances.

Results of analysis of some of these flare effects yield some useful information on the physical conditions of the ionosphere. The results appear to indicate the existence of *two* types of flare effects, called type A and type B here, which differ mainly in their relaxation times.

Comparison with observations at Sydney taken during a period of comparatively low sunspot activity shows that during 1957-58, when the sunspot activity was very high, the F region contribution has increased by a larger factor than the D region contribution.

4. N. N. SEN and S. R. KHASTGIR (Calcutta) : *Evidence of Solar Activity in the Waveforms of Terrestrial Atmospherics & in the Fading records of Radio-Signals.*

The present paper is concerned with the sunspot activity and solar flares and their effect on the waveforms of atmospherics and on the fading patterns of the radio-signals.

There is considerable increase in ionization in the lower regions of the ionosphere during *some* solar flares, due to $L\alpha$ or $L\gamma$ radiation from the hydrogen flocculi in the vicinity of the sun-spots on the photosphere. This causes fade-outs for short-wave radio-transmission and mirror-like reflection for *very long* waves from the edge of the ionospheric layer. In the latter case, a lowering of the reflection height is expected, when there is a large increase of ionospheric ionization. The waveform records of atmospherics (which are pulses of very long radio-waves) taken during the solar flares have shown that the reflection height, as determined from the time-intervals of the successive ionospheric reflections has *at times* a distinctly lower value. The typical records showing lowering of ionospheric reflection height in some cases and no lowering in others have been illustrated. A distinct lowering of reflection height during intense meteoric activity is also shown for comparison.

The geo-magnetic activity due to the active sunspots and during the solar flares has shown some observable effects in the wave-form patterns of atmospherics. The 'run-away' electron envisaged in Wilson's theory of separation of charges in a thunder-cloud, positive in its upper and negative in its lower part, move upwards

in an intense electric field within the cloud. At the time of the spark discharge, these electrons go beyond the positive upper part with extremely high velocity and are likely to reach the E-layer causing extra ionization. It is likely that even the normal geomagnetic field may deflect the 'run-away' electrons to the lower regions under favourable conditions. If however, there is a large increase in the geomagnetic field due to any active sunspot group or due to any flare, the conditions become more favourable for the 'run-away' electrons to be deflected downwards, and these electrons coming down to the lower regions may cause a decrease in the electric field within the cloud, increasing thereby the effective field between the lower negative charge and the ground. As a consequence, the 'steps' of the initial leader should be longer and the *quasi*-frequency of the 'predischarges' or of the 'stepped' pulses should be of a lower value. The increase in the effective field between the negative cloud and the ground should also be more favourable for the 'hook'-field changes. In some of the waveform records, taken during the solar flare or geomagnetic activity, the 'predischarges' or the 'stepped' pulses from a leader of some lightning source superposed on the c-field change of another discharge have shown a *quasi*-frequency of 8-10 Kc/s, instead of the average value of 20 Kc/s. A number of waveform records have shown 'hook'-field changes during geomagnetic activity.

The fading patterns observed with vertical *pulsed* transmission on 3.8 Mc/s have indicated *very rapid* fading indicative of the *turbulent* state of the F-region during geomagnetic disturbances and solar flares. There have been distinct evidences of a *reversal* in the direction of the ionospheric drift followed by *extremely rapid* fading during geomagnetic activity and solar flares.

5. S. S. BANERJEE (Banaras) : *Diurnal and seasonal variation of electrical conductivity of the ionosphere with increasing sunspot activity.*

The electronic conductivity of the ionosphere is responsible for deciding the lowest usable frequency for zonal transmissions at different times of the day and different seasons. This again depends on the phase of the eleven-year sunspot cycle. The study of the ionospheric conductivity is further important for securing the knowledge of the changes in geomagnetism. The conductivity of the ionosphere, however, is usually estimated by determining the total absorption of the radio waves reflected from the different reflecting layers. The total absorption therefore has been studied in details by a large number of investigators, particularly in the higher latitudes.

The study of the total absorption in the lower latitudes has shown that the absorption decreases as the frequency of the exploring wave is increased in the frequency region much below the critical frequency of F2 region. Near the critical frequency however, the absorption is found to increase with the exploring frequency. Seasonal variation of the absorption show winter anomaly as observed in the higher latitudes.

Diurnal variation of the total absorption at lower frequencies show that it increases with the advance of the day and reaches the maximum sometime after the noon hours. The above variation at high frequencies however, shows two maxima of total absorption, one before and the other after the local noon. The double increase in the absorption during the day at higher frequencies is attributed to the lowering of deviative absorption of these waves in the F2 region of the ionosphere during the noon hours due to the thermal expansion of the region which occurs under the adiabatic condition. The above effects are observed for transmissions at vertical as well as oblique incidence. The observations during the four years from 1954 to 1957 indicate that the total electronic conductivity of the ionosphere increases by about 50 per cent due to the increase in solar activity.

6. S. N. MITRA and B. C. NARASINGA RAO (New Delhi) : *Effect of Annular Solar Eclipse of 19 April, 1958 (at Sunrise) on the F-2 Layer of the Ionosphere.*

The paper describes the effect of the Annular Solar Eclipse of 19th April, 1958, on the ionisation density of the F-2 layer over Trivandrum, Tiruchirappali and Madras (South India). The eclipse occurred near sunrise at all the three places and its magnitude at maximum phase was 75 to 83%. Analysis of $(f^o_{F2})^2$ values during control period and eclipse day showed a marked decrease in the ionisation density with the progress of the eclipse at all the three places. Theoretical considerations of the effect of an eclipse at sunrise on the ionisation density of the F2 layer are discussed which led to the determination of the value of attachment co-efficient at 350 km as approximately 10^{-5} Su^{-1} over Trivandrum.

7. B. N. BHARGAVA and A. P. JAYARAJAN : *A study of Equatorial F-scatter in Relation to Solar Activity.*

A preliminary study of spread echoes was undertaken by one of the authors in 1957 based on data collected at Kodaikanal for about one year. A more exhaustive study of equatorial F-scatter during night hours has been discussed in the present paper utilising Kodaikanal ionospheric data over a period of about 4 years from 1955 to 1959. The occurrence of spread-F has been studied both qualitatively and in respect of the intensity of the phenomenon. The incidence of spread-F has been classified according to the frequency region where the phenomenon appears and the degree of intensity of spread has also been taken into account.

The data have been analysed for diurnal and seasonal changes. The effect of geomagnetic activity and various aspects of solar activity such as sunspot number have also been studied. The reasons for reduced spread-F during intense magnetic activity at low latitude are also discussed at the end of the paper.

8. R. P. KANE (Ahmedabad) : *Solar Activity and Cosmic Ray Intensity Variations.*

During the past two decades, continuous measurements of Cosmic Ray intensity have revealed some striking associations of the intensity changes with events occurring on the sun. Evidence is presented here for :—

- (1) Changes in mean intensity of Cosmic Rays exhibiting association with the 11-year sunspot cycle.
- (2) 27-days recurrence tendency in the variation of the daily mean intensity. Dependence of the amplitude of this variation on sunspot activity.
- (3) Cosmic ray storms and association of some of them with peculiar solar events.
- (4) Solar flare effects on mean Cosmic Ray intensity.
- (5) Diurnal variation of Cosmic Ray intensity and its association with solar activity.

9. S. BISWAR, P. J. LAVAKARE, K. A. NEELAKANTA and P. G. SHUKLA (Bombay) : *Evidence for a Forbush type of decrease in the intensity of heavy nuclei of the primary Cosmic Radiation.*

Evidence is presented for a large Forbush type of decrease in the intensity of the heavy nuclei ($Z \geq 6$) of the primary cosmic radiation, occurring on March 13,

1956. The energy spectrum was measured using a stack of emulsions flown from Iowa. No specific conclusion could be drawn about the energy dependence of the decrease.

10. PRABHAT K. SEN GUPTA (New Delhi) : *IV Solar Activity and Weather.*

1.

Although the energy of solar radiation is regarded as constant for all practical purposes in explaining weather, there are short and long term anomalous fluctuations in weather phenomena, which may be attributed to variations in solar radiation as a result of solar activity. Examples are afforded by the various climatic trends, the so-called Index cycles covering 3 to 8 weeks, and even the long period geological cycles when the climate alternated between the glacial and interglacial, or pluvial and interpluvial.

In spite of the tremendous difference between the periodicities of the Index Cycles and the geological glacial cycles, a marked similarity in the pattern of climatic changes has been long noticed (Craig and Willett). For instance the Glacial ages as well as Low Index periods are characterised by an intensification and expansion of polar anticyclonic circulation, displacement of climatic belts and zonal wind system towards the equator, development and intensification of the meridional pattern circulation and increase in temperature gradient towards the poles. With the advent of High Index of Interglacial conditions, the polar circulation weakens and shrinks, the climatic belts and zonal wind system move towards the poles, and the circulation pattern becomes more zonal. The expansion and contraction of the polar ice-cap follow the same trends.

2.

According to an interesting theory due to Simpson, the geological fluctuations could be successfully accounted for by assuming that the solar radiation undergoes variations large enough to cause significant variations in temperatures over the earth as a whole. A rise in temperature would intensify the general circulation, increase evaporation, to be followed by increased cloudiness, rain and snowfall—typical of the glacial conditions. The process is reversed when the temperature falls. The available records of solar constant do not show such large variations to bring about the typical glacial and interglacial conditions as envisaged by Simpson. In fact, during the period for which the records are available, although alternations between the two index types occurred, extreme glacial and interglacial conditions did not exist. But, as pointed out by Craig and Willett, in the historical past, for instance, in the 13th and 14th centuries A.D., when glacial conditions prevailed and large and numerous sunspots were seen in Europe, the insolational energy must have exceeded all known values. During the mild period of 1672-1704 A.D. in Europe (corresponding to interglacial conditions) not a single sunspot was seen. This relationship of sunspot activity with index features, viz., sunspot maxima associated with low Index Type has been noticed by many investigators (Hanzlik, Köppen, Walker, Willett and others). The effect is manifested in some kind of periodic fluctuations in temperature, pressure, rainfall patterns, and displacements of storm tracks towards the equator or the poles (Helland-Hansen, Humphreys Tannehill, Sen Gupta and others).

3.

It follows from the above results that even when the solar constant is practically constant, there are active solar features, viz. plagues, faculae, surges, flares

etc., associated with sunspot activity, which influence weather phenomena. But so far the attempts to find relationships between individual physical features on the sun, and weather have not been fully successful. There are, however, a few examples of direct influence of a solar feature on the general circulation pattern. For instance, Duell and Duell found that significant variations in pressures over Europe and Greenland-Iceland areas occurred soon after a magnetic disturbance. Scherhag, Willett and Palmer have associated a rise of temperature in the upper atmosphere with the increase in energy of ultra violet or corpuscular radiation from a disturbed sun (viz., during flare activity).

4.

Judged from the effects on the earth, solar activity is manifested as increased output in ultra-violet and corpuscular energy in the solar radiation. Chapman estimated that under very favourable conditions, the corpuscular energy output could augment the value of solar constant by about 10%, but unlikely to influence meteorological phenomena, as the penetration of the corpuscular radiation is limited to levels above 95 Km. If a limited amount of the sun's variable radiation in the ultra-violet is able to reach the upper confines of our atmosphere, it should be possible to account for the fluctuations of the general circulation in terms of the variation of absorption of ultra-violet radiation. Baur has been able to establish a relationship between sunspot cycle and areas of sun's faculae which radiate more in the ultra-violet generally during the sunspot minima.

Wexler, however, feels that even if the outer fringes of the atmosphere are influenced by the absorption of varied amounts of solar ultra-violet energy, the disturbances are likely to be damped considerably by the time the lower atmosphere is reached. But whatever the mechanism by which energy is transmitted to the atmosphere may be, there is ample evidence to show that the temperature of the whole atmosphere is influenced by sunspot activity. For instance, it has been noticed that in the lower latitudes and tropics the temperatures over the surface (Humphreys) as well as the upper atmosphere (Sen Gupta) have a tendency to fall during sunspot maxima and rise during sunspot minima, giving rise to corresponding displacements of isotherms and circulation patterns.

11. K. R. RAO and T. N. SESHADRI : *Solar Insolation Curves.*

Based on the data presented by Threlkeld and Jordan, curves for the variations in the intensity of direct solar radiation, incident on a surface normal to the sun's rays, with solar altitudes for different water vapour and dust contents of the atmosphere are given in this paper. These curves facilitate easy computations of the solar insolation on any surface, on clear days, at any latitude, at any time, on any day of the year, (i.e. for a known position of the sun, as determined by its declination, altitude and azimuth at the time), provided the water vapour and dust content of the locality are known.

Data on the atmospheric precipitable water and dust content for different places in India, are not however generally available. In the absence of such definite data, it is the usual practice to carry out the computations for an accepted standard condition when the atmosphere contains 15 mm. precipitable water and 300 dust particles per c.c. The curve for this standard atmosphere is also given as one of the family of curves presented in the paper.

Calculations carried out using these curves compare well with the observed values generally. It is hoped that these curves will simplify considerably the calculations involved in obtaining solar insulations for engineering and architectural needs, and as such will be found helpful.

II. ELEMENTARY PARTICLES AND HIGH ENERGY PHYSICS

President : DR. S. PARTHASARATHY, Delhi.

1. S. K. SRINIVASAN and K. VENKATESAN : *Photo-production of Pions by a Nucleon.*

Double photo-production of pions by nucleons is examined on the basis of "fixed extended" source theory of Chew and Low. A linear integral equation for the matrix element is derived using the Tamm-Dancoff approximation. Using the solution of Chew and Low for single pion production, an expression for the cross section of the process is obtained as a first approximation. The total cross-section compares favourably with the experimental results of Sellen, Cocconi and Hart. It is found that the angular distribution of pion-pairs is sensitive to the state of polarisation of the incident photon beam. Photo-production of three pions is also investigated using polarized photon beams and cross-sections are presented.

2. ALLADI RAMAKRISHNAN, S. K. SRINIVASAN and N. R. RANGANATHAN (Madras) : *Pion production in Pion-nucleon collisions.*

An equation of the Low type has been formed for the pion production in nucleon-nucleon encounters. Some numerical results based on this equations are presented.

3. ALLADI RAMAKRISHNAN, N. R. RANGANATHAN, R. VASUDEVAN and S. K. SRINIVASAN : *On Dispersion theory.*

Dispersion theory is examined on the basis of reciprocal relationship between the real and imaginary part of the scattering amplitude and it is shown that the knowledge of the absorptive part over unphysical region leads to linear integral equation for the dispersive part.

4. ALLADI RAMAKRISHNAN, S. K. SRINIVASAN and R. VASUDEVAN : *Formalism.*

The equivalence between Feynman expansion and S-matrix formalism has been demonstrated in a simple and obvious way without recourse to Wick's theorem.

5. ALLADI RAMAKRISHNAN and R. VASUDEVAN : *Kernel functions and perturbation theory.*

The old-fashioned perturbation theory has been recast in a form which is manifestly covariant and its equivalence with Feynman's kernel function formalism is also established.

6. R. VASUDEVAN and P. RAJAGOPAL : *On Feynman's derivation of Schrodinger equation.*

Feynman's derivation of Schrodinger equation bears close correspondence to some limiting processes of the basic random processes.

7. VACHASPATI : *Invariance of wave equations of Massless particles of spin $\frac{1}{2}$ I. Four component equation.*

Invariance of the massless Dirac equation under continuous transformations is examined. The widest group under which the equation is invariant is shown to

be the relativistic conformal group. Explicit expressions for the transformed wave function and equations are given. The extent to which the charge conjugate solution may mix is determined.

8. A. N. MITRA and P. NARAYASWAMY: *Green's function techniques for 3-field systems.*

A 4-dimensional non-perturbation approximation scheme for mesons, photons and nucleons which was proposed by Arnowitt is studied in detail in momentum space. This formulation combines the advantages of the Tamm-Dancoff approximation whose physical basis is clear at every step with those of the Bethe-Salpeter method which, on the other hand, has 4-dimensional invariance and hence facilitates renormalization. In the present work, the approximation scheme restricts the number of intermediate particles to three. The amplitude of present interest is the Green's function for one nucleon in the presence of an electromagnetic field, which may be simply related to the usual vertex operator of Feynman-Dyson theory. This amplitude which is manifestly gauge-invariant, satisfies two coupled integral equations containing many divergences. The renormalizations of these divergences are being carried out. The finite part of the resulting amplitude can be employed to extract the magnetic moment of the free nucleon, to an order of approximation which goes much beyond the limits of the conventional non-perturbation treatments. This last programme still remains to be worked out by an approximate solution of the resulting divergence-free integral equations.

9. R. P. SAXENA: *Two-pion annihilation of a nucleon-antinucleon pair.*

The annihilation of a nucleon-antinucleon pair into different charge states of a two-pion system is investigated employing New-Tamm-Dancoff method. The resulting integral equation is then solved for eigen states of total isobaric spin (T) and angular momentum (J). It was noted that the empirical selection rules for Nucleon-Antinucleon annihilation given by Bethe and Hamilton automatically follow from the present formalism.

10. T. PRADHAN and B. DEO: *Vacuum polarisation due to charged neutrinos.*

It is shown that the entire vacuum polarisation due to charged neutrinos (upto second order in e) can be considered as a renormalisation factor without giving rise to any observable effects. This is quite in contrast to the result obtained by putting $m=0$ in the formula for vacuum polarisation due to electrons, which gives an infinite value for the observable part of the vacuum polarisation.

11. GYAN MOHAN: *On the description of unstable particles.*

An attempt is made to develop a non-perturbative theory of unstable particles. The standard framework of quantum mechanics coupled with certain asymptotic conditions form the basis of the entire development. The asymptotic conditions are just the mathematical formulations for the system to separate out into free particles in the remote past and future. These conditions are an integral part in the definition of the conventional S-matrix. Unlike most of the recent attempts no particular model is used and it is shown that under very general physical assumptions the mass, the lifetime and also the mass renormalization of an unstable particle may be defined. A comparison is made with the Field Theoretic treatment of unstable particles by Peierls and by Mathews and Salam.

In addition to these original papers, there were six invited talks, four relating to experimental work and two to theory. One of the lectures on theoretical topics was delivered by Professor Abdus Salam, F.R.S.

I. RECENT ADVANCES IN ELECTRO-ANALYTICAL TECHNIQUES

Section of Chemistry

Chairman : DR. A. K. BHATTACHARYA, Agra.

1. N. A. RAMAIAH and R. D. SRIVASTAVA (Kanpur) : *Polarographic determination of calcium in molasses using disodium salt of ethylenediamine-tetraacetic acid (EDTA).*

Estimation of calcium in sugar house products is an important problem facing sugar industry. The calcium content in a number of samples of molasses obtained from different sugar factories in India, was estimated amperometrically using disodium salt of EDTA. Sodium zincate was used as the indicator, which did not react during the course of the titration, but reacted with the excess of the reagent to give a sharp change in the polarographic current. The physico-chemical phenomena involved were elucidated from the knowledge of the dissociation constants of the various complexes existing in the system.

The accuracy of the titration was verified against standard oxalate, and Schwarzenbach's indicator ((murexide) methods; the results of different methods agreed within 1 per cent.

2. N. A. RAMAIAH and H. C. SARASWAT (Kanpur) : *Polarographic estimation of cadmium in presence of nickel, cobalt and bismuth.*

Cadmium was estimated amperometrically using 0.3 M $K_4Fe(CN)_6$ as titrating agent, with an experimental inaccuracy of 0.5 per cent. In the presence of citrates employed as supporting electrolyte for the reduction of Cd^{2+} at the dropping mercury electrode, the presence of Ni^{2+} , Co^{2+} , and Bi^{3+} did not interfere with the estimation, due to the formation of more stable citrate complexes of Ni^{2+} , Co^{2+} and Bi^{3+} than the corresponding ferrocyanide complexes.

3. H. C. GAUR (Delhi) : *Application of electroanalytical methods to fused salt media : Electrolysis at constant current.*

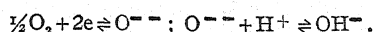
The fundamentals of electrolysis at constant current of chronopotentiometry and the previous work in the application of this technique in aqueous and fused salt media shall be reviewed. Results of the chronopotentiometric measurements in the reduction of Ag^+ and Ni^{++} in fused potassium chloride—lithium chloride at $450^\circ C$ will be discussed. Platinum microelectrodes of different areas and geometries were employed. The transition time was limited to be of the order of 0.5 seconds, and an oscillographic method of recording was employed. It was found that so long as the dimensions of the electrode were much greater than the diffusion field, linear diffusion theory was obeyed. The transition time constant for the reduction of Ag^+ and Ni^{++} were found to be 1.278 and 0.688×10^3 amp cm sec² per mole, and the diffusion co-efficient were calculated to be 3.43 and 6.54×10^{-5} cm²/sec.

4. B. P. GYANI and RAM KISHORE PRASAD (Patna) : *Different functions of the bright platinum electrode.*

From a large number of titrations carried out with the bright platinum electrode it appears that it may be made to function in more than one way. Thus, it may be made to follow the ratio of ferric to ferrous ions in titrations where the ferric ions are removed by complex formation e.g. with acetate, citrate or fluoride.

It was found that these titrations may be carried out without introduction of external ferrous ions. Perhaps the ferrous ions may be produced by reduction of the ferric ions by photochemical action or traces of organic substances usually present.

Precipitation of ferric hydroxide may be regarded as an extension of these titrations since metal hydroxides are considered as complex compounds by Schwarzenbach. It was found, however, that salts of many metals e.g. Zn, Cu, Pb, Cr and Co may be accurately titrated with NaOH. In some of these cases there cannot be the possibility of following an oxidized form to reduced form ratio and the only alternative view why these titrations are possible in presence of a bright platinum electrode appears to be due to its functioning as a hydrogen electrode directly or indirectly. The electrode has been treated in various ways before use and the experience gained from these experiments supports the view that the electrode in the first instance works as an oxygen electrode,



Any electrode which can follow the concentration of OH^- ions automatically follows the concentration of hydrogen ions. The success attending many titrations of salts and acids with NaOH clearly indicated that the E° for the electrode remain substantially constant. The electrode was therefore also used for measuring pH's of a series of buffer solutions, with moderate success.

5. B. P. GYANI and S. N. PRASAD (Patna) : *Stages in the reduction of acid permanganate.*

If conditions are suitable acid permanganate may be quantitatively reduced to the oxidation states MnO_2 , Mn_2O_3 or MnO . The state MnO_2 may be easily attained by the use of KI, KNO_2 or KBr as reducing agent. Only half a mole of KI is required for this purpose in dil. sulphuric acid (up to 1.0N). At 2.3N sulphuric acid the permanganate loses more oxygen. 0.66 mole KI is required and the reduction proceeds to the Mn_2O_3 state. At still higher concentrations (up to 6N) the KI requirement is 0.83 mole indicating final reduction to the MnO state. The iodate which is formed at first then reacts with more KI and a final inflexion at 5.0 moles is obtained in all cases. With KNO_2 manganese di-oxide is invariably formed at first (1.5 moles nitrite) which is subsequently reduced to the MnO state, 2.5 moles nitrite. With KBr the first inflexion is at 3 moles (0.1 to 2N acid). The value increases to 4.7 moles at 4N acid but again falls steadily with increasing acid concentrations, 3.9 moles at 8N.

Titration have been also performed in which the permanganate has been delivered from a burette and others in which HCl replaces H_2SO_4 , with interesting quantitative results. These titrations open up possibilities of titrating accurately mixtures of permanganate and iodate, permanganate and manganic salts, etc. They also provide automatically checks on the final titre when permanganate alone is present.

6. K. S. G. DOSS (Karaikudi) : *Recent advances in electroanalytical techniques.*

Electroanalytical techniques comprise methods of chemical analysis based on phenomena associated with the reactions at metallic electrodes in contact with electrolytes and with the passage of electricity (i.e. transportation of ions to electrolytes) through the electrolytes. The field being very vast, it is proposed to deal with :

- (a) the more important newer electroanalytical techniques and
- (b) any important recent progress in the older electroanalytical techniques.

Amongst the newer electroanalytical techniques, special mention may be made of chrono-potentiometry which was developed chiefly as a valuable means for elucidating that the mechanism of electrode reactions has high analytical potentialities, which are worthy of exploitation. In this connection, the work of Iwamoto and co-workers on dropping scale chrono-potentiometry is of interest, in that the estimations can be carried out with very small quantities of solution. Similarly the newer modifications of polarography, such as Univector technique and square-wave polarography are worthy of mention. The most important development in the field of polarography is perhaps the radio frequency polarography developed by G. C. Barker based on the redoxokinetic effect, which enables analysis of solutions containing millimicro quantities of metals in as small a volume as 1/100 cc. of solution. Two new potentiometric methods for finding out the end point of titrations have been developed, namely admittance titrations and redoxokinetic titrations. The former is based on the sudden change of admittance at the end point and the latter is based on the sudden change of redoxokinetic potential at the end point. Amongst the other important electroanalytical techniques are (a) the use of electric discharge as detector of organic vapour in vapour phase chromatography; (b) the development of the rotating dropping mercury electrode by Kolthoff and (c) the square-wave titrimetry being developed by Laitinen and co-workers. Automatic titrimetry based on electroanalytical methods has been extended to a variety of estimations.

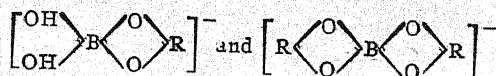
7. R. D. TIWARI (Allahabad) : *Paper Ionophoresis in the separation of natural products.*

The different rates at which various organic ions move under the influence of an electric field towards anode or cathode enable separation of complex mixtures of closely allied substances like sugars, protein hydrolysates, blood serum and nucleic acids isolated from natural products. This is the principle of ionophoresis.

This technique is complementary to paper chromatography but has the additional advantage that a clear cut separation of the acidic, basic and the neutral products is possible at the initial stage and a combination of the two techniques would give a complete picture. Thus it offers a simple microanalytical technique of great value.

The most important factor effecting the movement of ions is the pH of the electrolyte. Thus amino acids in acid buffer (acetate buffer pH 4) will be present as cation $\text{NH}_3^+ \text{---} \text{COOH}$ and will migrate towards cathode, while in alkaline buffer (borate buffer pH 9 to 10) they would be present as $\text{NH}_2 \text{---} \text{COO}^-$ ion which will move towards anode. At the isoelectric point, they would be present as a true Zwitter ion $\text{NH}_3^+ \text{---} \text{COO}^-$ and will not migrate. Since different amino acids have different isoelectric points, at a given pH they will in general migrate at different rates in the electrical field. This is the principle of the separation of amino acids.

Although carbohydrates are electrically neutral, in the presence of the borate buffer, majority of the carbohydrates move towards anode during ionophoresis. Because carbohydrates are polyhydric compounds, they react with borate ions as polyhydric alcohols do. Thus if sugar is represented as $\text{OH} \text{---} \text{R}$ the mechanism can be explained by visualising the formation of ions of the type



It is these two ions that migrate during ionophoresis. The maximum mobilities of the carbohydrates are at pH 9 in presence of the borate buffer which is therefore used for the separation of the carbohydrates.

A combination of the two techniques of paper chromatography and paper ionophoresis has been successfully employed in the study of a large number of other natural products.

8. A. AZIZ KHAN and WAHID U. MALIK (Aligarh) : *Polarographic study of biuret reaction.*

Amongst the electrochemical methods used for determining complex ion formation polarographic technique occupies unique position. Although spectrophotometric methods do give useful information for soluble complex formation, the polarographic methods have got several advantages over spectrophotometry.

The biuret reaction has been studied by spectrophotometric and chemical methods, but very little has been done to study the reaction by employing electro-metric techniques. Polarographic studies of a number of complexes viz. copper biuret; copper malonamide; copper serine; copper asparagine; copper casein; copper gelatine; copper egg-albumin and copper triglycylglycine, were carried out. Nickel and cobalt complexes of biuret, serine and malonamide were also studied.

The reduction of biuret, serine, malonamide and triglycylglycine complex takes place with one electron transfer while in case of asparagine two electrons are involved in electrode reaction. In case of biuret and serine one molecule of each combines with one atom of copper while in case of malonamide and asparagine two molecules of each take part in complex formation. The structural formulae of these complexes have been discussed.

Nickel (yellow) and cobalt (reddish brown) complexes of biuret, malonamide and serine were found not to be reducible at the dropping electrode before the reduction of sodium ions of the supporting electrolyte starts. Violet complexes of casein, egg-albumin and gelatine were also not reducible at the electrode. The non-reducibility of protein complex was attributed to the colloidal nature of the molecules.

9. P. R. SUBBARAMAN, P. S. SHETTY and J. GUPTA (Poona) : *Niobium in Tantalum.*

Electro-analytical techniques have often proved more useful on several occasions where the time-honoured classical methods are long and tedious. For instance, difficult pairs such as cadmium-zinc, tungsten-molybdenum, or selenium-tellurium can be analysed polarographically by a proper choice of the supporting electrolyte. Possibly, even zirconium may be estimated in presence of hafnium since zirconium oxychloride in methanol gives a well-defined step. Attempts to estimate niobium in tantalum by taking advantage of the reduction step of pentavalent niobium in certain supporting electrolytes have not met with definite success.

The niobium wave in nitric acid is not diffusion controlled but results from a kinetic reaction in which nitrate ions are reduced. In hydrochloric acid, the wave is very sensitive to acid concentration and is non-existent below a concentration of 6 molar hydrochloric acid. The reduction steps obtained from complexing media are also not particularly satisfactory. Thus the wave from an oxalate or tartrate solution is seriously interfered with hydrogen discharge. The niobium step in EDTA is reversible but in the given pH range 2-4, the latter is only sparingly

soluble. According to Ferret and Milner, the most useful wave is obtained from a two-molar citric acid solution at pH 1. However, the $E_{1/2}$ of this wave is $-0.86V$ vs SCE in which region titanium interferes. This is a serious drawback since in any scheme of separation, titanium invariably accompanies niobium.

Experiments carried out in this Laboratory indicate that niobium gives an irreversible step in a triphosphate as well as a pyrophosphate base electrolyte. In 0.2M sodium triphosphate at pH 7, the wave has an $E_{1/2}$ around 1.6V vs SCE. Though well-developed, the wave tends to merge with the discharge of the supporting electrolyte. This interference is practically eliminated by taking a derivative polarogram. The diffusion current is also proportional to the niobium concentration in the range 0.3—1.8mM. Below 0.3mM, the definition of the wave is poor. The interference from titanium is practically eliminated at this pH.

The niobium step from a solution of sodium pyrophosphate is similar to that from triphosphate but even in the derivative polarogram interference from discharge of supporting electrolyte is not adequately eliminated. Niobium solutions in pyrophosphate medium are also much less stable.

10. B. CHATTERJEE (Howrah): *Clay membrane electrodes for the measurement of cationic activity.*

Clay membrane electrodes have been successfully used for the determination of single cation activities. The use of these electrodes has made possible studies of the ionization of single cations from colloidal systems. The clay membrane electrodes consist of small discs of clay films heated at the desired temperature and fixed at the ends of pyrex glass tubing. These electrodes are then soaked in a fairly concentrated solution of a salt of the particular cation concerned to eliminate asymmetry potential. A solution of known cation activity is placed inside the tube and the latter is then put in the solution under examination. The chemical cell under consideration can be represented as follows:—

Calomel Electrode	Saturated KCl Soln.	Solution of known cation activity (a_1)	Clay Membrane	Solution of Unknown cation activity (a_2)	Saturated KCl Soln.	Calomel Electrode
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From a consideration of the membrane permeability theory and assuming that the density of the negative charge on the membrane is high, it has been shown that the equation for the total potential of the cell reduces to the well known Nernst equation. The potential difference between the inside solution and the outside solution is determined by potentiometric method using two calomel half-cells, and the cation activity of the test solution is calculated using the well known Nernst equation.

$$E = \frac{RT}{nF} \ln \frac{a_1}{a_2}$$

So far, clay membrane electrodes have been effectively used for the determination of single cations, ammonium, sodium, potassium, calcium, magnesium, barium, copper, zinc, manganese, and cobalt. The particulars of the clay membranes generally used for the determination of the above cations have been briefly presented here for ready reference.

Cation Estimated		Clay mineral used for preparing Membranes		Membrane saturated with	Temperature of pre-heating
Ammonium	Montmorillonite	Hydrogen	490°C
Sodium	Beidellite	"	550-600°C
Potassium	Montmorillonite	"	490°C
Calcium	Beidellite	Calcium	600°C
Calcium	Montmorillonite	Hydrogen	410°C
Magnesium	"	Hydrogen	"
Barium	"	"	"
Copper	"	"	600°C
Zinc	"	Calcium	"
Manganese	"	"	"
Cobalt	"	"	"
Cobalt	"	"	700°C

The range of activity over which the Nernst equation is valid has been found to depend on (i) the nature of the cations of which the activity is measured; (ii) the nature of the cation saturating the membrane; (iii) the clay mineralogical make up of the membrane; and (iv) the temperature of heating the membrane. The results so obtained show that the range of cation activity over which satisfactory results have been obtained is between 0.0001 and 0.0081 for calcium, barium, magnesium, copper, manganese and cobalt and between 0.0001 and 0.243 for ammonium, sodium and potassium and between 0.0001 and 0.0243 for zinc.

Attempts have also been made (i) to determine the individual cation activities in mixtures of two cations by determining the mobility ratio of the two cations concerned, and (ii) to develop selective membranes which would respond to a particular cation in mixtures of cations. While some promising results have already been made in these lines, it is premature to draw definite conclusions on these issues at the moment.

II. MECHANISMS OF DISPLACEMENT REACTIONS IN ORGANIC CHEMISTRY

Chairman : DR. A. K. BHATTACHARYA, Agra.

1. P. MADHAVAN NAIR and ARTHUR J. FRY: *Isotope effects in the reaction between benzyl chloride and potassium cyanide.*

As part of an effort to utilize isotope effect measurements to throw some light on the nature of the mechanistic transition from "S_N 1" to "S_N 2", the Cl³⁵-Cl³⁷ and C¹²-C¹⁴ isotope effects in the reaction between benzyl chloride and potassium cyanide in aqueous ethanol have been determined. The values are 0.74 ± 0.05 per cent respectively. The significance of these values and of the available kinetic information on the reaction will be discussed.

2. SANTI R. PALIT (Jadavpur): *Factors influencing the course of free radical displacement reactions in solution.*

Displacement reactions, also called abstraction reactions or transfer reactions, are very common in free radical chemistry. Some well-known examples are—

- (1) $C_6H_5^* + CHCl_3 \rightarrow C_6H_6 + CCl_3^*$
- (2) $Na^* + CH_3Cl \rightarrow NaCl + CH_3^*$
- (3) $CH_3^* + C_6H_6 \rightarrow CH_4 + C_6H_5^*$

All these typical examples show some features difficult to understand theoretically. For example in the first reaction, the other alternative reaction, $C_6H_5^* + CHCl_3 \rightarrow C_6H_5Cl + CHCl_2^*$ does not take place at all. The second reaction is basically an electron transfer reaction like the well-known Fenton's reaction, $Fe^{+++} + H_2O_2 \rightarrow (Fe^{++++} + OH^-) + OH$ but takes place with a measurable speed in the gaseous phase. The third reaction is peculiar in the sense that when a free radical attacks an aromatic compound, it behaves in sharp contrast to the aliphatic compounds and instead of preferentially abstracting a hydrogen finally abstracts the aromatic ring without any bias to orientation.

These typical examples thus show that there is a preferential path in any free radical displacement reaction and it is the prime task of the theoreticians to formulate some principles which would be capable of predicting the course of such displacement reactions.

It is easy to surmise that highly reactive radicals cannot afford to be selective in attack. Thus, of Cl and Br atoms the former displaces any hydrogen atom of a solvent in its vicinity, but Br atoms being less reactive is often exclusive in its attack, preferring the weakest CH bond, say, the tertiary bond, if present. OH radicals at 90°K when it reacts with an alcohol has the remarkable selectivity of displacing a hydrogen atom of the CH bond but not of the OH bond.

The susceptibility of attack in a free radical displacement reaction on a C-H bond depends mainly on the following factors.

- (a) C-H bond strength
- (b) Stability of the attacking group and the displaced radical
- (c) Polar factor
- (d) Steric factor
- (e) Environmental factor, such as temperature, pressure, medium, etc.
- (f) The well-established fact that radical attack on hydrocarbons is remarkably selective the reactivity being in the order $ter > sec > pri$ is undoubtedly due to this factor. High polymeric radicals also conform to this trend.
- (g) This is probably the most important factor in reactions involving free radicals and has been profusely confirmed. The extent of bond breaking in the transition state has been lately suggested as an important factor.
- (h) The fact that 'alpha' CH is less readily attacked than 'beta' of carboxylic acid or a terminal chloride by a chlorine atom whereas the reverse is true for attack by methyl groups seems to be associated with some kind of polar factor, such as polar deactivation by electron-withdrawing group and the electrophilic or nucleophilic nature of the attacking radical.
- (i) Attack on peripheral atoms may be looked upon as preference due to steric reasons.
- (j) Solvents have lately been found to have strong influence on free radical reactions it being recently found that the same free radical reaction in aromatic solvents producing results quite different from those in aliphatic solvents.

With the accumulating experience of the behaviour of free radicals it appears that a new chemistry is being born whose laws may be different from but as enigmatic as the chemistry of molecules.

I. RECENT WORK IN ANGIOSPERM MORPHOLOGY

Section of Botany

Chairman : DR. S. K. PANDE, Saugor.

1. B. M. JOHRI (Delhi) : *Angiosperm embryology*.

During recent years embryology of angiosperms has received considerable attention particularly in India.

Taking the anthers first we may refer to the work of Cooper (1952) on *Lilium henryi*. According to him DNA is transferred from the tapetal cells to the microspore mother cells during meiosis. This was considered to be a fixation artifact by Taylor and McMaster (1954) but Linskens (1956) has confirmed that DNA does escape from the degenerating tapetal cells and nuclei in the form of nucleotides and is utilized by the microspore mother cells for synthetic processes.

Ram (1959) has reported a peculiar behaviour of sporogenous cells in the microsporangia of *Leptomeria billardieri*. Instead of undergoing reduction divisions and forming tetrads, the cells enlarge and after three successive mitotic divisions each cell shows eight nuclei which finally organize like an embryo sac. Whereas in *Hyacinthus* (see Maheshwari, 1950) embryo sac-like structures develop from microspores, in *Leptomeria* they develop directly from the sporogenous cells and such a behaviour has not been reported in any other plant.

Concerning the types of embryo sacs attention may be drawn to Billings' (1937) work on *Isomeris arborea*. He considered the embryo sac to be tetrasporic (Adoxa type) with only two synergids and an endosperm nucleus. Maheshwari and Khan (1953) and Sachar (1956) report that the development is monosporic (Polygonum type) and a normal gametophyte is produced.

Dicraea and *Hydrobryum* (Podostemonaceae) have been studied at the University of Delhi. In these plants the development of the embryo sac is so different from that of the Allium type that it appears justifiable to revalidate the Podostemon type under the bisporic embryo sacs.

Martinoli (1948) in *Peperomia maculosa* and Murty (1959) in *P. pellucida* and *P. comarpana* observed that the embryo sac may show one or two synergids and a variable number of polar nuclei and peripheral cells. Thus, both *Peperomia pellucida* and *Peperomia hispidula* types occur in the same species and there seems to be no necessity of including two subtypes under the *Peperomia* type.

More than one type of embryo sac development has been reported in the same species, e.g. in *Tamarix gallica* and *T. pentandra* (Johri and Kak, 1954) there are four types of embryo sacs—Fritillaria, Drusa, Adoxa and Chrysanthemum cinerariaefolium. In *Tridax trilobata* (Hjelmqvist, 1951) the embryo sac is mostly monosporic, sometimes bisporic; while in *Cassiope mertensiana* (Palser, 1952), *Ehretia laevis* (Johri and Vasil, 1956) and *Benincasa cerifera* (Chopra and Agarwal, 1959) it is mostly bisporic and sometimes monosporic.

Similar variations are also known in different species of the same genus, e.g. *Olox imbricata* (Fagerlind, 1947) shows monosporic development while in *O. wightiana* (Shamanna, 1954) the embryo sac is bisporic. Most species of *Cuscuta* show a monosporic embryo sac but in *C. reflexa* (Johri and Tiagi, 1952) it is bisporic. Harling (1951) reports that mono-bi- and tetrasporic development occurs in different species of *Erigeron*.

The variable behaviour of nuclei during megasporogenesis and gametogenesis offers a most intriguing problem and the interpretations put forward by Fagerlind (1944), Harling (1951), Smith (1955), Gerassimova-Navashina (1957) and Flint and Johansen (1958) are hardly convincing. We must await further researches in this field.

The nuclei of the synergids and antipodal cells often show high polyploidy which is usually due to endomitosis. In some species of *Allium* (Hasitschka-Jeushke, 1958) one or more synergid and antipodal nuclei become octoploid. In *Aconitum* (Tschermak-Woess, 1956) and *Papaver rhoeas* (Hasitschka, 1956) the antipodal nuclei may become 64n or 128n.

Development of a caecum from the chalazal end of the embryo sac is well known. In *Nuytsia* (Narayana, 1958) and *Atkinsonia* (Garg, 1958) a caecum arises from the micropylar end. A peculiar situation exists in *Exocarpus strictus* (Ram, 1959). In this case a fringe of finger-like processes directed towards the antipodal end develops from the middle region of the embryo sac.

The endosperm of *Cocos nucifera* (Cutter *et al.*, 1952, 1954, 1955; Henry, 1956; Datta, 1953, 1955) has been studied in great detail. In *Erythronium* (Oikawa, 1953), which shows a Fritillaria type of embryo sac, the endosperm should be pentaploid but actually it is diploid since the chromosomes of the triploid nucleus (lower polar) are eliminated during divisions. The size of the nuclei in different parts of the endosperm is sometimes variable. In *Zea* (Duncan and Ross, 1950) in the central part of the endosperm the nuclei grow by endomitoses up to 1,000 times of their original volume.

At the University of Delhi, development of endosperm has been investigated in the Acanthaceae, Cucurbitaceae, Leguminosae, Loranthaceae, Santalaceae and several other families. In *Elytraria* (Johri and Singh, 1959) the endosperm is cellular from the very beginning and no 'basal' apparatus is formed. In the Cucurbitaceae (Chopra, 1955; Johri and Roy Chowdhury, 1957; Chopra and Agarwal, 1958) and Leguminosae (Johri and Garg, 1959) a chalazal haustorium and in Loranthaceae (Maheshwari, Johri and Dixit, 1957) composite endosperm are conspicuous features. In *Tapinostemma* (Garg, 1959) the basal cells of the composite endosperm enlarge and produce finger-like processes which have a haustorial role. This is comparable to the condition in the Santalaceae. In *Comandra* (Ram, 1957) a lateral caecum arises from the micropylar portion of the embryo sac even before fertilization and later it functions as the primary endosperm haustorium which invades the placental tissue. Secondary haustoria arise from a cell cut off at the base of the primary haustorium.

Yakovlev and Yoffe (1957) pointed out that in *Paeonia* the nucleus of the zygote undergoes repeated free nuclear divisions resulting in a vesicular coenocyte. Subsequently wall formation takes place producing a cellular mass. The latter does not directly differentiate into an embryo but instead certain peripheral cells form meristematic centres which give rise to embryonal primordia. Only one of these develops into a dicotyledonous embryo. This was such an unusual feature that it could not but raise doubts about its accuracy. One of our co-workers, Miss Prem Murgai (1959), who has investigated several species of *Paeonia* from different parts of the world has convincingly demonstrated that the first division of the zygote is invariably followed by a wall. The basal cell enlarges considerably and becomes coenocytic. Yakovlev and Yoffe overlooked the small apical cell and misinterpreted the multinucleate basal cell to have arisen as a result of free nuclear divisions of the zygote.

Another instance of a still more serious mistake may also be mentioned. Billings' (1937) was unable to trace the development of the embryo sac and embryo in *Isomeris arborea* and claimed that the embryo arises from an endosperm nodule. This has been doubted for a long time until in 1956 my colleague, Dr. R. C. Sachar showed that in this plant the embryo develops as usual from the zygote and the proembryo has a long and coiled massive suspensor of multinucleate vesicular cells which in a section appears in the form of nodules along the periphery of the embryo sac. Since these are imbedded in the free nuclear endosperm, Billings mistook them for endosperm nodules.

The work of Indian botanists has proved very useful in determining the limitations and relationships of a number of families, e.g., Alismaceae, Butomaceae, Cyperaceae, Palmae, Lemnaceae, Zingiberaceae, Orchidaceae, Santalaceae, Loranthaceae, Viscaceae, Cercidiphyllaceae, Limnanthaceae, Stachouseiaceae, Alangiaceae, Sphenocleaceae and others.

The above selected examples will serve to indicate that many significant advances have been made in angiosperm embryology in recent years.

2. S. NARAYANASWAMI (Vallabh Vidyanagar): *Morphology of the embryo in the monocotyledons.*

The nature and constitution of the angiosperm embryo has been a fanciful subject of numerous investigations and interpretations by several botanists ever since the time of Caesalpini, Malpighi, and Ray during the sixteenth and seventeenth centuries. However, it was not until the end of the eighteenth century that a fresh impetus was given to a critical study of the true nature of the embryo from the time of Jussieu (1809) who proposed his classification of the angiosperms broadly into two groups based on the number of cotyledons. Even to this date, the problem of the genesis of the monocot embryo and the homologies in the embryo of the Gramineae in particular, are by no means settled and remain controversial.

In spite of the unmistakable relationships that exist among angiosperms, it is becoming increasingly evident that their arbitrary division into two co-ordinate subclasses, viz., monocots and dicots is not entirely natural. Both the types of the embryos originated from an early cylindrical, club-shaped axial body in which the cotyledons is supposed to be terminal and the shoot apex lateral in the case of the monocotyledons and the reverse in the dicotyledons. Attempts to ascertain whether the single cotyledon is truly terminal or initially lateral which has come to occupy a distal position, have resulted in evidence in support of both the views. Studies on certain monocotyledons lead one to conclude that the explanation based on the conception of unequal cotyledonary development or of the early abortion of one cotyledon is not in accordance with the facts of ontogeny. This would corroborate the earlier observations of Hanstein (1870) on *Alisma*, Schaffner (1897) and Johri (1935, 1936) on *Sagittaria*, and by Agrawal (1952) on *Lilaea* that the single massive cotyledon could be explained in terms of abortion or suppression of the second cotyledonary primordium in an initially potential dicot organisation. On the other hand it is probable that the inception of the monocotyledonous condition may be the result of a genetic change in the course of evolution from ancestors possessing two or more cotyledons (Wardlaw, 1954).

The graminean embryo is exemplified by the possession of several special organs such as the scutellum, coleoptile, epiblast, coleorhiza, mesocotyl etc. Extensive developmental studies of the grass embryo are being carried on for almost a century and a half as evidenced by the conflicting views expressed in literature pertaining to the problem of homologies of the several parts from the time of van Tieghem (1872), Bruns (1892) and Kennedy (1899) to the present day investigators like Reeder (1953), Roth (1957) and Jacques Felix (1958). One is struck by the persistent diversity of these concepts—the embryologists from the point of view of the histogenesis of the plants and the anatomists of vascularization. Certain authors have found the unity of plan between the graminean embryo and those of other monocots. The recent objective researches of Percival (1927), Avery (1930), Boyd (1931), McCall (1934), Young (1938), Marrasse (1938), Jakolev (1946), Reeder (1953), Roth (1955), Tucker (1957) and Jacques Felix (1958) establish the fact that the coleoptile diverging from a well-defined node with roots and axillary bud, is undisputably a foliary sheath. The term 'mesocotyl', much in vogue, cannot be conserved for descriptive use.

The current trend of thought on the genesis of the monocot embryo has been to find an equivalence of the parts of the graminean embryo with those of the fully developed plant.

The coleoptile is identified with a pre-leaf, a two-nerved organ, bicarinate, without a limb, carried as the first member by the bud which lie latent or developed and which grows at each of the nodes of the stems. Its position is definite. The 'gemma' of which the coleoptile is the pre-leaf, is the lateral bud of a pre-existing 'podium' which is the scutellar-radicle axis. The latter possesses a single node, that of the epiblast which is a rudimentary leaf and in whose axil the initial bud of the plant arises protected by the coleoptile.

According to this view, the scutellum to which is attached the coleoptile, is the main axis of the embryo. This mode of development is the first act of sympodial growth which is normal in perennial gramineae. The developmental sequence in the formation of the lateral members, viz. the scutellum, epiblast, coleoptile and the first plumular leaf, follows as an approximately phyllotaxial plan. Such a generalised conception could be extended equally well to all monocotyledonous embryos. In the monocots the mode of growth is generally sympodial and is observed again in the embryo, where the principal axis aborts in forming the terminal cotyledon while laterally it differentiates itself into a new axis of growth which behaves as the first. Souèges (1931, 1954) from a study of *Sagittaria sagitifolia* and more recently on *Potamogeton natans*, confirms this point of view.

In a recent review Jacques Felix (1958) agrees with Souèges on the terminality of the scutellum and the laterality of the gemma but differs as to the organic value and the constitution of its parts. According to him, the scutellum is the superior part of a pre-existing axis and not a terminal foliary segment of the value of a cotyledon. The embryonic configuration is such as to denote the first sympodial growth in Gramineae. This is in agreement with Souges according to whom every internode and its leaf are so many defined axis following each other for the construction of the caulm although Jacques Felix envisaged this mode of growth confined only to the rhizomatous stump derived from an original embryonic body of axial nature considered as a telome. The term cotyledon as applied to the axial scutellum is, therefore untenable and would be more appropriate for the epiblast.

In conclusion, the graminean embryo could be construed as made up of two distinct parts :

- (i) the embryonic axis or the protocorm which represented the heterotrophic phase of the sporophyte, and
- (ii) the axillary bud of the protocorm which will furnish the principal stem portion of the plant.

By reason of its advanced seminal ontogeny, this embryo already constitutes a complex plantule, a blastophyte. The seminal bud is homologous with that which appears only at the germination in the undifferentiated embryos of the Orchidaceae and termed as the 'adventitious plantule'. In showing that the embryogenic axis is well-defined at its two poles—the superior part, viz. the scutellum playing a role in the storage and in the heterotrophic assimilation, and the inferior part satisfying the supply of water to the blastophyte at germination, and with an intermediary nodal zone, it favours the idea of protocorm and probably permits their extension to the entire group of monocots.

3. G. C. MITRA (Lucknow) : *Morphology of stipules in the dicotyledons.*

Stipules are one of the important diagnostic characters in taxonomy. The major role of stipules seems to be the protection of young developing leaves. As to its morphology confusion still prevails among some botanists and again very recently the very old issue that certain stipules are 'free' (cauline) while others

are 'adnate' (petiolar) has been raised. A morphological entity will have two types of ontogeny!

The ontogenetic studies of different types of stipules of dicotyledons, viz. free-lateral, adnate, interpetiolar, intrapetiolar, foliaceous and ochraceous and of the so-called bud scales of *Ficus* species and of others made recently by Engard, Mitra, Majumdar and Mitra, Majumdar and Pal and Sensarma have revealed their true morphology in detail, their vascularization, their genetically determined growth correlations with other parts of the embryonic leaf and with the axis and their differentiation. These investigations also confirm that three parts of a typical dicot leaf, namely, the base, the petiole and the blade can be distinguished anatomically.

Mitra, and Mitra and Majumdar while considering the morphology of the stipules as leaf-base divergence have brought out that the leaf-base of dicotyledonous leaves must be regarded as composed of two regions: the 'axial component' (i.e. the portion of the leaf grown with the axis during internode development in an active bud and usually traversed by a trace or traces) and the 'free' base (i.e. the portion of the leaf between the 'axial component' and the petiole of a petiolate leaf or the blade of a sessile leaf). Based on the relative vertical growth of the two regions, three types of leaf-bases are found in dicotyledons, namely, (i) the leaf-base consisting of the 'axial component' only in such a case the petiole or the blade as the case may be, sits directly on the axis; (ii) the leaf-base consisting of the 'axial component' for the most part with a little extent of 'free' bases; and (iii) the leaf-base consisting of the 'free' base for the most part with a little extent of 'axial component'. The development of the stipules either from the 'axial component' or from the 'free' base is correlated with course and branching behaviour of the lateral traces or bundles through these regions. Stipules of the leaves having the first category of leaf-base will invariably leave cauline scars if they are shed. In the leaves having the second type of leaf-base the stipular scar may or may not be cauline. These explain Parkin's 'free' (cauline) stipules and solve cross cauline stipules in *Morus alba*. These ontogenetic studies conclusively demonstrate that in the dicotyledons the stipules of any kind are products of the leaf-base and not of the stem.

It appears that most of the previous workers have not seriously considered the 'axial component' of the leaf as its part while describing the origin and development of a leaf. Some botanists have not regarded the leaf-base as a morphological element of the foliage leaf on a par with the blade and petiole.

4. K. SUBRAMANYAM (Coimbatore) : *Floral morphology.*

Progress in the field of floral morphology has been remarkable and very significant as we look back and try to outline it. Among the many advances in this field two lines may be mentioned: first, the acquisition of a large amount of factual material for comparative interpretations, and for testing earlier theories and proposal of new ones; second, the emphasis on the comparative view-point for determination of evolutionary progress and establishment of probable natural relationships.

In the internal structure of the flower, floral anatomy provides many useful characters in addition to those of external structure and it may be used in taxonomic and phylogenetic studies. Internal characters are as valuable as the external and some are more useful because of the frequent persistence of the vascular supply of lost organs after all external evidence of the organs has disappeared. The vascular vestiges throw light on ancestral forms and also provide evidence of relationship to other groups. Professor Eames has been the pioneer in this field and he is mainly responsible for this concept of comparative morphology. A recent example where floral anatomy, along with other evidences from

anatomy, embryology, cytology and ontogeny, has been specifically useful in determination of taxonomy and phylogeny is the removal of *Paeonia* from the Ranunculaceae and the establishment of the family Paeoniaceae, in the Dilleniales, far Ranales.

Thus the recent work on floral morphology emphasizes the critical importance of cooperation of morphologists, taxonomists and other disciplines of study in taxon limitation and in the establishment of natural relationships.

5. S. K. JAIN (Poona) : *Morphological characters and their significance in the taxonomy of grasses.*

The various characters of vegetative and reproductive parts of grasses have been described, such as habit, culm, leaf, leafsheath, auricle, leafblade, inflorescence, spike, spikelet, pedicel, involucre glumes, lemma, palea, lodicules, stigmas, stamens and awns. The value of these characters as fixed characters has been emphasised. Their range of variation depending on habitat has been indicated and their value in distinguishing various taxa of grasses has been discussed. It has been pointed out that excepting characters like ligule, vegetative characters are usually subject to considerable variation depending on habitat and should not be singly used in dichotomous keys. Characters which are not conveniently discernible or can be misleading in herbarium specimens such as contracted or loose panicle, abaxial face, should be avoided in keys as single diagnostic characters. Several qualitative terms as slender or thick have been found to be of less taxonomic value.

Examples have been cited from several grass genera.

6. G. PANIGRAHI and R. V. KAMATHY (Shillong) : *Studies on Indian biotypes of Taraxacum officinale Weber.*

Taraxacum officinale var. *parvula* Hooker has, of late, migrated presumably from the Himalayas and Mishmi hills and is spreading as a weedy species along the grassy slopes of the Shillong hills (1525 m.), under the partially exposed canopy of *Pinus insularis* Endlicher and is associated with *Galinsoga parviflora* Cav., *Erigeron annuus* Pers., *Richardsonia pilosa*, HB & K., *Drymeria cordata* Wall and *Paspalum dilatatum* Trin etc. The roots which provide 'Decoctum Taraxaci' etc. of commerce, penetrate about 20 cm. below the soil layer which is of reddish clay and loamy in nature.

Study of mitosis and meiosis in some of these Indian biotypes reveals that $2n=8$ and $n=4$, in contrast to the lowest number $2n=16$ in the non-Indian biotypes, which are also characterised by polyploid and aneuploid forms. Homology of chromosomes between 2 of the 4 pairs, however, is only partial, resulting occasionally in 2 to 4 univalents per cell. In a few plants with $2n=9$, the extra chromosome migrates to one of the poles only. Discovery of $2n=8$ thus brings down its basic number from $X=8$ to $X=4$.

Although existence of both sexual and apomictic forms in non-Indian forms is known, *T. officinale* var. *parvula* in India is a sexual species without any evidence of apomixis. It flowers from April to November and forms 74% good pollen grains; normal pollination and fertilisation yields profuse fruits which are crowned with pappus of great morphological interest.

7. H. L. CHAKRAVARTY (Calcutta) :

The morphology of classical taxonomists had to pass through many critical tests by experimental and floral morphologists. The old conception of organs have been

retained in some but revised in many. The flower being an essential organ of an angiospermic plant has been subjected to critical analysis by the morphologists from different angles. The vascularization of the floral members has been given much stress in recent years to find out the pattern mainly with the object of taxonomizing it. Floral pattern of a particular species, genus or even a family leads us more clearly to a path, greatly removed from obstacles, to establish the interrelationships of plants closely related or widely separated. The origin of the sepals, petals, stamens and the carpels and their morphological variations have been studied very carefully during the past fifteen years; in the Continent, the U.S.A. and in India these problems have been tackled with more interest. The outstanding figure in the realm of floral morphology comes from the Continent. Eichler as back as 1875 and Van Tieghem in the same year conceived, how essential it was for botanists to make critical observations of vascular floral patterns and their relationships with one another for solving many problems of affinity. Blüthendiagramme published by Eichler in 1875 opened out a new vista of thoughts for the taxonomist and rightly he has been frequently quoted by Engler in his works on angiospermic taxonomy (*Pflanzenfamilien* and *Pflanzenreich*).

In Cucurbitaceae the morphology of the stamens less so the carpels remained unsolved and debatable for a long period. Heimlich (1927), Saunders (1936) and others considered the male flowers as three staminate. Works on different species of Cucurbitaceae with special reference to staminate flowers at the Botanical Laboratory of the Presidency College reveal that there are basically five stamens in the family. The two bithecal stamens are formed by the combination of two adjacent monothecal stamens and hence are compound in nature. The odd stamen is not a half stamen but a simple stamen minus a theca a monothedious simple stamen.

Why a theca has disappeared yet remains unsolved but it has been observed that with the elongation of the theca the pollen chambers became much convoluted probably for space adjustment and evolution has perhaps feebled and degenerated one of the two forks of vascular traces supplying the two thecae of an anther and a simple theca ultimately survived. With the elongation of the loculi the need for a loculus of a couple has been curtailed. Vestigial trace of the degenerated loculus is yet to be discovered. Examination is in progress.

II. DYNAMICS OF SOIL FUNGI

1. T. S. SADASIVAN (Madras) : *Soil Fungi and Plant Roots*.

The nature of the organic material in the soil in various stages of decomposition plays a significant role in determining the type of fungal flora and its physiological activities in soil. Several factors cause wide variations in this substrate fungal relationships in soils; one of them is contributed by plant roots which significantly affect the dynamics of soil fungi in diverse ways. Primarily, the rhizoplane and the rhizosphere offer a substrate rich in nutrilites, cellulose and other organic material. In many cases as the plants mature, the reaction of the rhizosphere soil changes from slightly alkaline to acidic pH and the latter is best suited for mould activity. There is ample evidence to show that the mycoflora is influenced both by the specificity of the plant and the phase of its growth. It is intimately connected with the normal metabolism of the plant and primarily on root exudations. Evidence indicates that this is not a one way affair; in fact, the activities of the rhizosphere microorganisms include decomposition of sloughed off root tissues and making available organic and inorganic nutrients for absorption by plants. The

soil inhabitant class of mycoflora and the soil invaders have, therefore, an important part to play in these processes. The metabolic products of the rhizosphere micro-organisms as well as the root exudates selectively affect the fungal flora in the rhizosphere. For instance, observations on the properties of powerful antibiotics derived from the plants *Aucuba japonica* and *Myrtus communis* indicate their potential influence on the ecology of microflora in the rhizosphere. The growth of *Ophiobolus graminis* along wheat roots was shown to be limited by the concentration of respiratory carbon dioxide at the root surface. Other factors limiting one or more fungi in the rhizosphere are the availability of essential heavy metals, toxic components of root exudates, etc.

Mycelial forms of great diversity enter into symbiotic relationship with rhizoids and roots of plants and the term "Mycorrhiza" generally pertains to proved examples of symbiosis. The degree of dependence of these fungi on the soil for their vital metabolic needs has not been precisely understood; nevertheless, it is generally known that penetration and infection of young roots by these fungi is from soil or from plant residues or by root contact. In the presence of appropriate fungi under artificial inoculation conditions, there is undoubtedly great increase in growth of seedlings. The probable mechanisms involved in this are broadly discussed.

2. C. V. SUBRAMANIAN (New Delhi) : *Substrate Relationships of Soil Fungi.*

One of the most fascinating aspects of the dynamics of soil fungi is their substrate relationships. Every soil fungus needs (a) specific substrate(s) for its growth and metabolism. There is considerable variation in regard to the choice of substrates by different soil fungi. There is also diversity in the nature of the substrates available in soils this is reflected in space and time. The soil substrate constituents are both organic and inorganic and, whatever may be the specific substrate, there is a conversion of organic substances into other types and/or into inorganic products by fungi or other microbes. Depending on the choice of specific substrates, fungi may be considered cellulophilic, lignicolous, coprophilous, etc. The fungi may be autotrophic or heterotrophic for various growth factors. The substrates would be partly used in building up cell material by fungi and in maintaining the pattern of metabolism characteristic of each fungus, leading sometimes to production of specific substances or metabolites in soils. The stability of these in soils and their effects on the associated mycoflora are important. The concept of succession of fungi on specific substrates is particularly true for soil fungi which exist in a complex, and usually dynamic, association of metabolically differing types. They would exert considerable influence on each other, competition for the available nutritional and energy substrates would occur and the products of metabolism of one fungus may have marked effects on others. There is evidence of production of various antibiotics, vitamins, growth substances, amino acids, etc., in soils and these may either be excreted by fungi or may be products of fungus-substrate interaction. The occurrence of specific fungi in soils, in definite *loci* or otherwise, the rise and fall of fungus populations including plant pathogenic ones, and the chemical activities of these fungi in soils, depend not only on their own innate nature and their interaction with the other soil microflora, but also on the substrates available. The problem is elucidated with special reference to litter-decomposing soil fungi.

3. L. SARASWATHI DEVI (Madras) : *Pathogenic soil fungi in relation to the inorganic nutrition of their host plants.*

Among the different vital metabolic processes of higher plants, inorganic nutrition occupies a key position. In obtaining the necessary elements from the soil

plant roots have to meet competition from the soil microorganisms. These can and do affect the availability of many mineral elements in the soil. The added ability of some of these microorganisms to invade and live in the tissues of higher plants brings with it fresh problems for the latter in maintaining the internal balance of the absorbed elements as well.

Besides rendering some elements present in enough quantities in the soil unavailable to the higher plant, by oxidative or similar reactions, soil microorganisms compete effectively for available elements when present in limited quantities. In this connection, the possible significance of the limited amounts of zinc in some cotton-growing soils of the Madras State is discussed with reference to the incidence of wilt caused by *Fusarium vasinfectum* Atk.

The systematic nature of infection in the case of the vascular wilts renders the entire plant subject to the disturbances initiated by the pathogens invading the roots. Indeed, almost every major metabolic process is altered in the infected susceptibles, which finally succumb to the attack. That the inorganic nutrient balance within a plant has much to do with its vitality and maintenance of a proper metabolic status needs no emphasis. Recent studies made in this laboratory showed that in the wilt-susceptible diploid cotton plants the internal ionic balance is profoundly upset following infection by the pathogen, *F. vasinfectum*. The most marked feature was a considerably low content of potassium in the leaves of affected plants. The view that this root-infecting soil fungus may be striking at its host's very basic process, viz., maintenance of an efficient internal ionic balance, seems to be strengthened by a later observation that normally resistant tetraploid plants showed similar ionic derangements when infected with the pathogen after pre-treatment with a metabolic depressant—maleic hydrazide. The significance of this finding is discussed in the light of other metabolic disturbances in cotton plants reported to be brought about by this pathogen.

4. C. S. VENKATA RAM, Devarshola (Madras) : *Factors affecting the spread of root-infecting fungi.*

Dissemination of 'root-infecting' fungi to fresh infection courts is achieved by a disjunctive spread of the fungal inoculum, by spores and Portions of the fungal tissue which are transported by various agencies over short and long distances, sometimes overcoming ecological barriers. Another mode of disease transmission is encountered in members of this group of fungi in which the fungal mycelium anchoring on a diseased plant attacks a healthy neighbour by conjunctive spread in soil, and *ipso facto* maintains effective infection potential. This lateral spread of 'root-infecting' fungi *in situ* occurs both as free or ectotrophic growth of the fungal mycelium in soil. Some of the 'root-infecting' fungi are capable of only limited growth in soil but these are root parasites of annual field crops, and here the infection potential of the pathogen lies in the fact that these fungi produce abundant spores or sclerotia in soil which lie in wait for the growing host roots in successive plantings. It seems obvious that most fungi infecting the root of plantation crops and forest trees have adapted themselves to the ecological niche in which they have to operate for their continued existence. Thus, if it were not for their ability to spread freely through soil over considerable distances, fungi causing primary root diseases in tea, coffee, rubber and cocoa plants, which are widely spaced, would not find suitable substrate for colonization, usually the healthy root of their hosts, once the tissue already invaded by them is either depleted of nutrients or decomposed by other soil fungi. Anchored to freshly infected host material the fungus can spread only as long as sufficient food reserves are available in the material colonized by them. This spread is achieved as growth of individual runner hyphae in some fungi, and as either mycelial aggregates or

rhizomorphs in others, in the latter these specialized strands of compact mycelium afford fungi the advantage of greater infection potential and ability to overcome host resistance compared to individual hyphae. Several physical and chemical factors determine both the formation of mycelial aggregates and rhizomorphs as well as their spread in soil and much of these have yet to be understood clearly.

5. C. B. SULOCHANA (Madras) : *Soil Mycoflora in relation to soil amendments.*

Amendments to soil, depending upon their composition, result in a sharp rise in certain forms of nutrients. This is followed by a discernible shift in the microbial balance and a more rapid decomposition of organic debris in the treated soils. Soil amendments can thus alter soil conditions, particularly the substrate fungal relationships, so as to favour the activity of several saprophytic forms which have been shown to increase the intensity of natural biological control of some root infecting fungi in disease infested soils. Study of this aspect is of considerable importance as such changes affects the spread, pathogenic potentiality and saprophytic survival of root infecting fungi in soils. Common root infecting fungi belonging to the genus *Fusarium*, many of which are also typical soil inhabitants, can be readily and consistently isolated from buried cotton stubbles and frequently from dilution plates. Under ordinary soil conditions, however, *F. vasinfectum*, the cotton wilt pathogen, and other fusaria do not make any extensive growth in and through bare soil, the main factor limiting growth of these fungi being antagonism of certain microorganisms. Nevertheless, *F. vasinfectum* is known to survive in soils over long periods in plant tissues already invaded during its parasitic phase as well as in a range of organic materials of which it is a primary colonizer. Extents to which organic and inorganic amendments promote or curtail the saprophytic potentialities of fusaria in soil have been investigated in this Laboratory. Beneficial effects and significance of amendments with particular reference to heavy metals, in controlling (i) conidial germination, growth and survival of *F. vasinfectum*, (ii) colonization of fusaria on buried stubbles, (iii) survival of *F. vasinfectum* and *F. udum* in artificially infected stubbles buried in amended soils are outlined along with the quantitative changes in the occurrence of soil fungi in general.

6.* D. SUBRAMANIAN (Madras) : *Some enzymological aspects of soil fungi.*

Considerable interest has centered round the rôle of pectolytic enzymes in the manifestation of diseases such as soft-rots, damping off of seedlings and wilts in recent years. Sufficient proof has been adduced to show that pectolytic enzymes do play a rôle *par excellence* in many diseases by their detection *in vivo*. A major difficulty, however, crops in when we attempt to base the physiology of parasitism of these group of fungal pathogens (facultative parasites) on their pectolytic enzyme relationships. There seems to be no parallelism between their capacity to secrete pectolytic enzymes *in vitro* and their pathogenicity *in vivo*. Some of the soil fungal pathogens secrete these enzymes constitutively while certain others like *Fusarium moniliforme* and *Sclerotium rolfsii* require the presence of pectin for protopectinase secretion. Partly adaptive nature of pectic enzyme secretion is also known in several cases. All these instances go to prove that a correlation between the ability of a fungus to secrete pectolytic enzymes *in vitro* and its pathogenicity or virulence *in vivo* is far from practicable, although a few instances are known where these two attributes run parallel. With the above facts in view, further elucidation of these interesting yet enigmatic questions was sought by studying a few pathogenic and saprophytic soil fungi in regard to their pectolytic enzyme secretion under varying cultural conditions. The results indicate that only the pathogenic or weakly pathogenic forms produce pectolytic enzymes in greater

quantities in a sugar medium in presence of pectin. A reduction in the concentration of sugar in the medium stimulated enzyme secretion by the pathogenic forms whereas, in the case of saprophytes it was lowered. When the availability of sugar was low the presence of pectin stimulated enzyme production only in the case of pathogens. The significance of these results in elucidating the phenomena of parasitism and pathogenicity is discussed.

7. M. LAKSHMANAN (Madras) : *Tissue respiration in relation to soil-borne plant pathogens.*

Soil-borne plant pathogens exhibit considerable dynamism in that they are capable of an expanding parasitic phase on a living host plant and a declining saprophytic phase after its death. In their parasitic phase the pathogens effect marked metabolic alterations which are more specific to any host-parasite complex than the secondary visible symptoms. Most of the metabolic processes are correlated in some way with respiration and changes in the metabolism of the host might be reflected by changes in respiration or *vice versa*. Diseases caused by soil-borne plant pathogens offer a facile field or respiratory studies since their ferment systems also can be investigated separately.

Diseases such as black-rot of sweet potato, footrot of rice, vascular wilt of cotton, *Cajanus* and tomato have been investigated with particular reference to respiration. The changes observed have, in most cases, been increased and much of the increase has been attributed to the host cells. The augmented respiration is at present believed to be caused by toxic metabolic products of the pathogens since their culture-filtrates when treated to healthy host tissues induced significant increases in the rate of oxygen uptake. Although much remains to be understood on the mechanism of increased respiration caused by soil-borne plant pathogens, some details have been elucidated by investigations on black-rot of sweet potato, wherein increased respiration has been shown to result, at least partially, from an 'uncoupling' action of an abnormal metabolite synthesized by the host as a result of infection. The probable rôle of 'respiratory toxins' have been postulated in wilt diseases since the hitherto identified wilting toxins have either no effect on the rate of respiration of the host or depress it. The rôle of terminal oxidases in the pathological increase in respiration is discussed. A correlation between respiratory status of hosts and their resistance or susceptibility to soil-borne plant pathogens is attempted.

8. K. BHUVANESWARI (Madras) : *Rhizosphere and root diseases.*

The effect of the growing plant on the dynamic equilibrium of the soil population is discussed. Though the changes in the equilibrium of the micropopulation may be detected among morphological and certain physiological groups, it is considered that an approach to the problem, capable of providing more knowledge of the meaning of the changes lies in the study of micro-organisms from the standpoint of their nutritional requirements in relation to root exudates. The difference in the rhizosphere microflora of different varieties of a single plant species resistant and susceptible to soil-borne pathogens even when grown entirely free from disease is discussed. The probable rôle of root exudates in determining the marked numerical difference in the microflora in the rhizosphere of resistant and susceptible varieties respectively to soil-borne disease has also been indicated. The effect of the root exudates of rice varieties resistant and susceptible to footrot disease on the growth and physiology of the pathogen and the possibility of the root exudate being one of the factors offering resistance to the entry of the pathogen in the case of the resistant variety is also discussed.

9. S. MALINI (Madras) : *Certain aspects of heavy-metal nutrition of some parasitic Fusaria.*

Since the growing of fungi in synthetic media began, the importance of heavy-metals to them has gathered tremendous momentum. Work on the indispensability of zinc, manganese, iron, copper, molybdenum, and boron to species of *Fusaria* is briefly reviewed. Work done along these lines in this laboratory on species of *Fusaria* causing wilts, are presented, treating the two phases of the life of these pathogens separately. During the first phase, when the *Fusaria* persist in the soil as saprophytes thus earning a place among the soil fungi, the part played by trace elements in their lives as evidenced by pure culture studies are detailed. Passing on to the second phase, viz., the parasitic phase of their existence, the role of trace elements as affecting and effecting the incidence and virulence of disease as seen from soil amendment studies are discussed. The heavy-metal pattern of the host plant as an essential part of the substrate for the parasite and its bearing on the parasitic capacity of the fungus are presented.

10. M. LAKSHMI KUMARI (Madras) : *Rhizosphere in relation to Virus Infection.*

It is well known that soil micro-organisms can be instrumental in immobilising or mobilising some of the essential elements in the soil, thus upsetting or balancing the nutrition of plants. The role played by the rhizosphere microflora in thus affecting the welfare of plants is discussed. It is interesting to observe virus infections very often producing in their hosts, symptoms, which resemble deficiency diseases. A study of the rhizosphere microflora of such plants may give important clues as to the availability or nonavailability of essential nutrients.

Some preliminary observations on the rhizosphere flora of virus infected plants are recorded here. Consequent on infection there is an increase in the fungal numbers in the rhizosphere as also in the actinomycete and bacterial numbers. An attempt is made to correlate it with the deranged metabolism of the host plant.

I. CRIMINAL POISONING (HUMAN & CATTLE) AND ITS INVESTIGATION IN INDIA

Section of Medical & Veterinary Sciences

Chairman : DR. A. R. NATARAJAN, Madras.

1. N. K. SEN (Calcutta) : *Criminal poisoning (human & cattle) and its investigation in India.*

1. The definition of a poison is not easy. There is no statutory definition of a poison. The Poisons Act of 1919 is not complete. Various classifications of poisons are possible. From the medical standpoint the mode of action in the body may be made the basis of classification. From the analytical and chemical standpoint, the chemical properties determining the methods of separating a mixture of poisons can be made the basis.

2. A table has been drawn up showing the type of poisons detected in human and cattle poisoning cases in the Forensic Science Laboratory, West Bengal. They have been arranged in order of their importance due to the frequency of their occurrence in the viscera. There has been a considerable change in the type of poison and the frequency. Therefore a change in the method of poison identification is necessary. As for example, newer poisons such as organophosphorus and

chlorinated—organic insecticides require specific procedures for their extraction and identification.

3. It is therefore necessary to include these newer poisons in the Poison Act of 1919 in order to exercise an effective control on the sale and use of these poisons. The special physical methods such as spectrophotometry, polarography, paper electrophoresis, paper chromatography etc. offer the possibility of identifying and estimating traces of many poisons.

2. N. K. IYENGAR and B. K. DATTA ROY (Calcutta) : *Criminal poisoning (human & cattle) and its investigation in India.*

The chemical and biological tests for poisons described in the literature are sometimes non-specific and are of little use when employed directly on the material. It is, therefore, necessary to employ techniques which will resolve complex mixtures into individual components on which the chemical and biological tests can be safely applied enabling the expression of a correct and definite opinion. The quantity of material available for the detection of poisons is sometimes very limited and hence microtechniques have to be employed. Paper chromatography and electrophoresis are invaluable tools for such separations.

Munier, Jatzkewitz and others have carried out a considerable amount of work on the chromatographic separation of a number of alkaloids. This work is of particular interest to toxicologists in India, who are frequently called upon to identify unknown poisons of plant origin. Systematic work on the isolation of different active principles from indigenous poisonous plants by paper chromatography has been undertaken in the Central Forensic Science Laboratory.

White (pink) and yellow oleander, Madar juice and aconite have been subjected to paper chromatography by using suitable solvents and developing agents. The results of this work are presented in this paper.

It will often be necessary to differentiate between an extraneous poison and the amine that might be produced by putrefaction. Gold Baum and co-workers have carried out a considerable amount of work on the subject by employing the technique of paper electrophoresis and by the use of Iodo-platinic acid as the staining agent. It has been possible to give definite opinion as to the presence or absence of a basic drug or poison in viscera even when putrefaction has already taken place. Work along this line is also being carried out in the Central Forensic Science Laboratory.

3. R. VIRA RAGHAVAN (Madras) : *Criminal poisoning (human & cattle) and its investigation in India.*

The use of poisons with criminal intentions is known in India from time immemorial; the ancient Indian scriptures contain references to the poisoning of kings and the misdeeds of professional poisoners. The diagnosis of poisoning and its treatment are mentioned in the treatises of Susruta, the Indian Hippocrates.

Two centuries ago poisoning was detected by circumstantial evidence and very often by invoking the aid of supernatural powers. Since the dawn of modern chemistry Plenck made a statement in 1781 that the only certain sign of poisoning was the botanical character of a vegetable poison or the chemical identification of mineral poison found in the body. The present day developments in the detection of poisoning are largely due to the advances made in chemistry and pathology. These two sciences form one of the essential wings of the investigation of criminal poisoning and the Law Enforcement Branch forms the other wing. The scientific wing works from within and the law enforcement wing works from without. These two must complement themselves completely.

A satisfactory and thorough investigation is possible only when there is comprehensive legal enactment regarding poisons and poisoning. The Poisons Act of 1919 is neither comprehensive nor up to date.

The scientific investigation of criminal poisoning comes under the discipline of Forensic Sciences, which is in its infancy in our country. A sustained effort is needed to nurture this child on healthy lines which can be attained only by a closer co-operation between the Law Enforcement Officer and the Forensic Scientist, each trying to understand the other's scope and limitations in his sphere of work. This involves the adequate training of Law Enforcement Officers in scientific crime detection, the adoption of standardised methods of toxicological analyses and close understanding between the pathologist and the analyst. Another desirable step would be the formation of an All Indian Association of Forensic Scientists for exchange of ideas, discussions on subjects of common interest and to standardise procedure and methodology so as to have uniformity all over the country.

II. INSECTICIDE RESISTANCE AMONGST ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE

Chairman : DR. A. R. NATARAJAN, Madras.

1. B. A. RAO, S. P. RAMAKRISHNAN and RAJINDAR PAL (Delhi) : *Present status of research on insecticide resistance in arthropods of medical importance in India.*

Wide-spread use of organic residual insecticides, during the last decade, has resulted in spectacular control of many arthropod-borne diseases. At the same time it has also brought in its wake the problem of arthropod resistance to the poison. The total number of resistant insect species of medical and veterinary importance are now estimated to be 61 against 1 in 1947. This has necessitated continuous vigilance for immediate detection of the cases of resistance in order to be able to implement remedial measures at the proper time.

In India so far only two cases of resistance in malaria vectors have been recorded. *A. culicifacies* to dieldrin and *A. stephensi* to DDT, BHC and dieldrin. *C. fatigans* is found to be resistant to DDT, BHC and dieldrin in some parts of the country. Houseflies, bed-bugs and body lice have also been observed to be resistant to some insecticides in use for their control.

Selection experiments in laboratory were carried out with *A. stephensi*, *A. fluviatilis*, *C. fatigans* and houseflies (*Musca* sp.) for a number of generations for DDT and BHC resistance. The results suggest, that insecticide resistance is a "pre-adaptive" phenomenon. Precipitation of resistance depends upon the frequency of the innate resistant factor or factors to be selected and the intensity of the selection pressure.

Genetical studies carried out by different workers have shown that in case of mosquitoes, resistance to kill is controlled by a single gene whereas in the case of flies the results are contradictory. Some have observed mono-factorial inheritance and the others poly-factorial resistance. In India, genetical experiments have been carried out with *C. fatigans*. It was found that the resistance to DDT is controlled by a single recessive gene located in one of the autosomes. Influence of cytoplasmic or maternal factor was also observed.

Biochemical studies on the mechanism of DDT resistance in *C. fatigans* and *A. subpictus* have shown that the rapid conversion of DDT to non-toxic DDE was one of the causes of resistance in these species. In the case of malathion resistant houseflies were observed to have less accumulation of acetylcholine, the lethal agent, than normal flies.

We have yet to do considerable research before we could evolve a perfect system of control measures to eradicate the insect vectors.

2. H. L. JHALA (Bombay) : *Insecticide resistance amongst arthropods of medical and veterinary importance—the necessity of the day.*

Ascher (1958) has shown that cetyl bromide was less toxic *i.e.*, produced less K.D. for the normal susceptible strains. It was almost equally more toxic to all the strains showing some type of resistance developed under some type of selection pressure. Crow (1952) mentioned that DDT resistant and multi-resistant strains were knocked down by alkali bromides when orally ingested, and much more quickly than normal strain. Mitlin, Babers and Barthel (1956) reported a crude preparation of the diisopropyl tetrachloroethylphosphate and that the active preparation when applied as selective agent killed more of DDT resistant houseflies as compared to S. strains. The third compound mentioned by Meltzer (1956) and quoted by Brown (1958) is phenylthiourea or phenylthiocarbamide discovered in experiments with DDT resistant strains of *Drosophila*. The significant fact that experimental studies have shown that resistance in house-fly develops much less rapidly with pyrethrins should not be lost sight of.

In the phenomenon of resistance one encounters the hand of the process of evolution. In the zeal to eliminate some of the harmful ones, one may encounter more disaster than otherwise unless properly planned. Busvine has expressed that control measures should aim only at the level of mortality necessary to prevent transmission and that more than this is wasteful and potentially dangerous. Hess mentions that unless new approaches are developed in future this phenomenon will bring an end to the DDT-era. The real solution to the insecticide resistance problem lies in return to fundamental research. We need to know more about the insect physiology and more still about its ecology, biology and their habits. The zeal to know them is wanting as many mainly concentrate on the methods of spraying the insecticides.

In medical entomology, the behaviour modification of vector species has now posed a problem for vector control, and the bionomics and behaviour of hematophagous arthropods are to be intensively studied.

I. ROLE OF MICRO-ORGANISMS IN SOIL FERTILITY

Section of Agricultural Sciences

Chairman : DR. B. N. SINGH, Lucknow.

1. W. V. B. SUNDARA RAO (New Delhi) : *Modern trends in microbiology in relation to agriculture.*

Emphasis is laid in recent years on the role of micro-organisms in the synthesis of plant nutrients, in the elaboration of vitamins and in the production of antibiotics that combat bacterial and fungal diseases of plants. Using N^{15} isotope, several photosynthetic bacteria and algae have been shown to fix atmospheric nitrogen. The amount of nitrogen fixed by algae, *Azotobacter* and legumes was estimated to be about 70, 50 and 140 lbs. respectively per acre annually. At the Indian Agricultural Research Institute, the efficiency of the root nodule organisms

was found to vary with the strains used in the case of gram, methi, peas and berseem. Further, the *Rhizobium* strains were also found to aggregate soil particles. Seed inoculation experiments with a mixed culture of *Azotobacter chroococcum* and cellulose decomposing organisms or with phosphobacterin gave significant increases in the yield of wheat grain in pot culture experiments. *Azotobacter* count was maintained in the soil at a higher level during the active growth period of the crop. Phosphobacterin inoculation gave in the field trials significantly increased yield of berseem. Efficient strains of *Azotobacter chroococcum*, and *A. indicum* and phosphorus solubilising organisms have been isolated.

Higher counts of amino acid requiring micro-organisms, actinomycetes and antibiotics synthesising organisms were obtained in the rhizosphere of berseem than in the control soil. Nitrogen fixation by *Azotobacter* and nitrosification by *Nitrosomonas* were accelerated by vitamin B₁₂. More information needs to be accumulated before seed inoculation could succeed either in controlling the pathogen or in increasing crop yields.

2. R. N. SINGH (Banarās) : *Rôle of blue-green algae in the nitrogen economy of Indian soils.*

Evidences adduced so far lead to the conclusion that the blue-green algae play a major rôle in the nitrogen economy of Indian soils. There is an unequivocal evidence that the recuperation of fertility in rice-fields is brought about by the algae like *Aulosira fertilissima*, *Cylindrospermum gorakhporensis*, *Anabaena ambigua*, and *Anabaena fertilissima*. The predominant rôle is played by *A. fertilissima*, which is the most powerful nitrogen-fixer, so far known, in rice fields of India and other South and Far East countries. Inoculation experiments with this alga under rice-fields conditions have shown that there is an addition of 47.6 pounds of nitrogen per acre of soil during one season and an increase of paddy yield by 114.8 per cent. Growth of paddy plants is increased in the presence of *A. fertilissima*. Nitrogen fixed by this alga is available to plants and it is possible to grow paddy in the absence of other sources of combined nitrogen.

There is a vigorous growth of blue-green algae in alkaline 'usar' soils during the rainy season and if this growth is encouraged it is possible to reclaim the soil in a few years. The process of reclamation is controlled by nitrogen-fixing blue-green algae like *Nostoc commune* and *fertilissima*. There is also a luxuriant growth of *C. licheneforme* and other algae in rabi fallows, kharif crops and sugarcane fields. The number of filaments is 18,000,000 per gram of cultivated soil and the amount of nitrogen added to soil is of the order of 80.25 pounds per acre per year.

From these results, it is inferred that nitrogen fixation in Indian soils, during the rainy season when the requisite moisture is available and nitrogen-fixing blue-green algae can grow in abundance, is mainly an algal process.

3. A. SANKARAM (Andhra Pradesh) : *A plea for the study of tropical legumes.*

The supply of available nitrogen in tropical soils is a limiting factor in plant growth. Almost the entire history of legume bacteriology has been written with legumes of the temperate regions, while greater number of both genera and species of Leguminosae are in the tropical and sub-tropical regions. Microbiologists in the tropics can ill afford to have this situation to continue, particularly when the root nodule organism associated with the legumes is widely recognized for its ability to fix sizable quantities of atmospheric nitrogen in comparison with other organisms that share this property.

Studies on the survey of the strains of *Rhizobia* present in soils of the major regions of our country, the serological behaviour of these strains for indentifying them, and the factors influencing the establishment of 'effective' strains in soil in competition with the native 'ineffective' strains and other soil microflora are of great importance. Nutman's work at Rothamsted has brought to light the importance of genetical aspects of the symbiotic participants, the host and the bacteria.

Mixed cropping has been a time-honoured practice in this country but our knowledge on the physiology and biochemistry of associated growth of legumes and cereals and the rhizosphere effects of root excretions is very inadequate. It may be that greater fixation of nitrogen lie in trace element deficiencies like molybdenum, the one element that revolutionised pastoral industry in New Zealand and Australia. Work at Indian Agricultural Research Institute has demonstrated the beneficial effects of phosphorus on legumes in general and of molybdenum on berseem. Example of New Zealand, where clovers alone are relied upon with confidence for nitrogen supply to the associated grasses in pastures and meeting deficiencies of phosphorus, lime and trace elements by use of suitable fertilizers, should stimulate thought and action of workers in India.

4. M. H. BILIMORIA and J. V. BHAT (Bangalore) : *Rôle of micro-organisms in the degradation of pectic substances in soil.*

Soil fertility depends on the extent to which complex organic materials are broken down by the micro-organisms that inhabit the soil. The breakdown of complex pectic substances, assumed to be of a vital significance in the binding together of certain plant tissues, is therefore of primary importance in soil fertility. What happens to pectin in nature in the soil, is repeated in the laboratory and in industry in the process of retting, wherein the binding material, pectin, is degraded and fibres of cellulose released.

In view of the importance of the degradation of pectin in nature, all micro-organisms available in our collection, including some micro-organisms of marine origin, were screened for their ability to decompose pectin substances. Some isolates were made with *Calotropis* (a plant commonly found in the arid areas in this country) as the inoculum or substrate in pectin enrichments or for retting respectively. The results obtained indicate that the pectin decomposing property is very widespread among micro-organisms. Among the pectin decomposing micro-organisms in our collection the following are represented : Bacteria (*Erwinia* sp., *Flavobacterium* sp. and an unidentified Gram-negative rod), Yeasts (*Cryptococcus laurentii* and an unidentified yeast) and moulds (*Fusarium* sp. and *A. niger*).

Quantitative data for pectin decomposition by most of the above isolates are available.

5. AMBIKA SINGH and D. P. JOHARI (Lucknow) : *Rhizobiophage research in retrospect and prospect.*

Temperate and virulent strains of rhizobiophages have been obtained from the root nodules, roots and stems of leguminous plants and from soil and sewage. Considerable work has been done on the various aspects of these phages. Vigorous research on host virus relationship of *Rhizobia* and their phages is being pursued at Rothamsted. In India some preliminary work has been done on the phages attacking *Rhizobia* of leguminous plants. The practical importance of these phages has not been fully appreciated by the agricultural research workers in this country.

How and to what extent these phages have been responsible to affect *Rhizobia* in nitrogen fixation still remains a speculation.

The applied aspect of rhizobiophage researches cannot be overemphasised in these days of food shortage in our country for they are associated with the nitrogen recuperation of our soils which, as a rule, are deficient in this element. Fundamental work is needed to understand the effect of these phages on the efficiency of local strains of *Rhizobia*. The importance of rhizobiophages in practical agriculture will be appreciated more and more when different aspects of host virus relationship are understood. The utility of green manures can be considerably increased by selecting phage resistant mutants of *Rhizobia*. The soil inoculation with phage races employed for the destruction of unwanted bacterial species and the seed inoculation with phage resistant strains are the two possibilities which can be of great help in securing high yield of legumes.

6. M. K. MUKHERJEE and A. K. BANERJEE (Barrackpore) : *Rôle of microbes in the maintenance of fertility of Jute field soils.*

The total amount of green matter produced per acre in jute is on an average 12-15 tons per acre and the jute plant takes up a very large amount of plant nutrients from the soil (150 lbs. or more of N, 200 lbs. or more of P_2O_5 per acre). But this heavy uptake does not result in impoverishment of the soil. On the contrary, a cropping with jute improves the soil in respect of nitrogen and available nutrient status of soils with reference to phosphates and potassium. This paradox can be partly explained by the amount of fallen leaves, a large number falling on the ground throughout the life of the plant. The organic nitrogenous substances in the leaves are as usual decomposed through different stages and ultimately nitrified. Apart from this, the extra nitrogen derived from cropping with jute seems chiefly due to *Azotobacter*. The crop season of jute is in an ideal condition for growth and activity of most micro-organisms. *Azotobacter* has been found to be more numerous in the plots cropped with jute than in non-jute plots as also in the rhizosphere (the area of the soil close to plant roots is known as *Rhizosphere*) of the jute plant than the outside soil. To what precise extent the greater concentration of *Azotobacter* in the rhizosphere or in soils cropped with jute helps the maintenance of nitrogen balance has to be found out. Jute does not usually respond to the application of phosphatic fertilisers alone or in combination with lower doses of nitrogen even in many soils which are poor in their content of available phosphates. A chemical mechanism in transformation of insoluble phosphates to soluble ones during the growth of the plant may be considered to be involved in the process but this cannot explain the whole process and it seems that micro-organisms play an important rôle, here too, in solubilising insoluble phosphates either through actions of acids or enzymes. Some phosphate-dissolving microbes have been found to be active during the growth of jute. From these it may be stated that microbes play an important rôle in the fertility maintenance of jute-fields.

7. G. E. FOGGY (London) : *Nitrogen fixation by blue-green algae.*

The fixation of nitrogen being connected with photosynthesis, the H_2 obtained from the product of photosynthesis is used for nitrogen fixation. Blue-green algae require comparatively higher amount of Mo. This may be a limiting factor in rice fields to get the maximum benefit from nitrogen fixation by blue-green algae. Fixation of nitrogen is more in swampy soils.

II. ROLE OF ARTIFICIAL FERTILIZERS IN INCREASING FOOD PRODUCTION

Chairman : DR. B. N. SINGH, Lucknow.

1. S. P. RAYCHAUDHURI (New Delhi) : *Use of artificial fertilizers in increasing food production.*

It has been estimated that crops grown in India remove from the soil annually 4.2 million tons of nitrogen, 2.1 million tons of phosphoric acid (P_2O_5), 7.3 million tons of potash (K_2O), and 4.8 million tons of lime (CaO). Intensive crop production depends on the efficient use of fertilizers and the question of adequate production of fertilizers is of major importance to India in view of its rapidly increasing population.

The consumption of nitrogen could reach the level of 5 lakh tons by the end 1960-61 at the end of the Second Plan Period against a target of 3.75 lakh tons. Also by the end of 1960-61, 150,000 tons of P_2O_5 and 60,000 of K_2O are expected to be consumed. By the Third Plan Period, the total estimated plant food requirements are as under :

Nitrogen 1.25 million tons N, phosphate 0.50 million tons P_2O_5 and potash 0.20 million tons K_2O .

It is emphasized that with limited quantities of fertilizers being available, it should be applied to good soils under optimum conditions of soil moisture.

2. R. V. TAMHANE and B. V. SUBBIAH (New Delhi) : *Scope for increased fertilizer use in Indian soils.*

As a result of mass analysis of soils, made possible through the establishment of a net work of soil testing laboratories throughout the country under the Indo-U.S. agreement, certain precise trends on all India basis for fertilizer needs could be assessed for the first time. The summaries of soil tests made on the basis of about 50,000 soil samples showed that 40% of all India soils are low and 30% are medium in phosphorus supply, thus showing that about 70% of the soils are likely to give from very high to moderate responses to phosphorus. With regard to potassium 26.6% of soils are low and 37.1% can be classified as medium. In this case only 26.6% of the soils are likely to respond to potassium in view of the experience in the field experiments that potassium fertilizers have not given much response to cereal crops in India. With regard to nitrogen, except for 9%, about 90% of the soils are likely to respond and give increases in crop yield. These data obtained have enabled to draw soil fertility maps on village basis and thus guide the farmers on fertilizer needs. The data indicate that the scope for the use of fertilizers is considerable both for nitrogen and phosphorus and to a limited extent for potassium.

3. P. K. SEN (Calcutta) : *Rôle of artificial fertilizers in increasing food production.*

Aristotle believed that plants derive nourishment through their roots from organic matter present in soil. Paracelsus advocated that salts are true nutrients of plants. Digby increased yield of crops by the application of saltpeter to soil. Saussure directed attention that ash ingredients of plants were taken from soil. His work was verified by Boussingault. Leibig laid the foundation of "mineral theory" in 1840 and his "law of minimum" demonstrated that minerals play an important rôle. Before 1900 elements *viz.*, C, H, O, N, P, K, S, Ca, Mg and Fe were thought to be needed for plant growth. Later Cu, B, Mn, Mo and Zn, needed in small quantities, were found essential. Na, Cl and I are also needed by some plants. N, P and K are of greater concern. N and P are the major constituents

of protein and K acts as a catalyst in the plant system. Calcium in small quantity in soil is essential for availability of other elements.

Results of 1,628 trials in paddy growing states indicate that 1.25 mds. of ammonium sulphate increase yield by 4.5 mds.; 2.5 mds. gave an increase of 6.6 mds. per acre. 1,300 experiments conducted in wheat growing tracts have shown that for every 1.25 mds. of ammonium sulphate applied there is a response of 2.5 mds. of increased yield per acre. Application of phosphatic fertilizers in 1,182 trials shows that 1.5 mds. of superphosphate increases yield of paddy by 3.6 mds. per acre. 1.5 mds. of superphosphate increase yield of wheat by 1.5 mds per acre. The usefulness of artificial fertilizers for other crops have also been established.

Artificial fertilizers alone cannot, however, give the best results as the humus status of the soil, ensuring its proper tilth, has also to be maintained. Every effort should, therefore, be made to utilize every bit of organic waste and green manures.

Increase in food production largely depends on use of artificial fertilizers. Manufacture of these should be stepped up for meeting the increasing demand for food due to increase in population.

4. DR. S. K. GHOSH (Calcutta) : *Relative response of ammonium chloride and other nitrogenous fertilizers as top dressing for the different crops on West Bengal soils.*

From the percentage average increase of nitrogen/lbs/acre, ammonium chloride has shown better results than Chilean nitrate or ammonium sulphate for sugarcane at Damodar flat land soil of Burdwan. At Ganga riverine soil of Behrampore the response of sugarcane with ammonium chloride was superior to Chilean nitrate, both at lower and higher doses. Percentage average increase with ammonium chloride and ammonium sulphate was the same in this region. At Ganga riverine soil of Malda and Buxa riverine soil of Coochbehar response of wheat with ammonium chloride was better than either with ammonium sulphate or Chilean nitrate at 40 and 60 lbs of nitrogen/acre. At Malda, next to ammonium chloride, Chilean nitrate proved better than ammonium sulphate.

In Aus wheat rotation at Damodar flat lands soil of Burdwan ammonium chloride responded better than ammonium sulphate in the case of Aus paddy both at lower and higher doses. Reverse results were obtained in the case of wheat in this region.

In Amon khesari rotation the response of ammonium chloride on paddy yield was the same as with ammonium sulphate at Ganga low land soil of Chinsurah, when paddy is grown either alone or in presence of khesari. In red soil of Nalhati and Ganga flat land soil of Mejihan ammonium chloride showed better effect than ammonium sulphate. The Chinsurah soil, being rich in plant nutrients compared to Mejihan or Nalhati soils, showed less response to fertilizers at Nalhati or Mejihan soils.

In most cases ammonium chloride produced better results than ammonium sulphate. This may be due to the formation of hydrogen sulphide from ammonium sulphate by the anaerobic decomposition of sulphate in water logged soils of West Bengal.

5. S. D. NIJHAWAN (Ludhiana) : *Rôle of artificial fertilizers in crop production.*

The chemical fertilizers give economic increase in yields when applied to different crops. Organic manures (farmyard) and compost (turn and village compost), when applied on equal basis of nitrogen as compared to the chemical fertilizers, give lower yield than the chemical fertilizers. In order to get maximum from our soil and water resources, the use of chemical fertilizers is essential. The data so far collected have shown that the constant application of chemical fertilizers

do not spoil the soil. The application of chemical nitrogenous fertilizers to wheat increased the protein content of the grain.

In order to have maximum benefit from the application of organic manures, they should be applied on the basis of available food nutrients in them. A method to determine this has still to be developed. Work is also needed in increasing the availability of nutrients which varies from 10 to 33%.

6. M. V. VACHHANI (Orissa) : *Rôle of nitrogenous artificial fertilizers in increasing rice production in India.*

The problem of increasing food production is of vital importance in the national economy as the food deficit in general and rice in particular is affecting the rapid economic development of the country. The yield of rice crop, which occupies about 80 million acres being nearly one third of the annual cultivated area under food crops in the country, is only about 772 lbs. per acre as compared to 2350 lbs. in Japan, 1953 lbs. in Korea and 1949 lbs. in China. The adoption of proper methods of cultivation is essential for raising the level of production.

Indian soils are generally deficient in nitrogen and an outstanding result obtained from the various manurial experiments conducted in the country is the universal response to nitrogen application in one form or another—the response, up to 40 lbs. of nitrogen per acre and with further increase in the level of application. Extensive investigations have been carried out at Central Rice Research Institute to determine (i) the optimum dose of the most important nutrient nitrogen, (ii) the comparative efficiency of various nitrogenous fertilizers, (iii) the optimum time and method of application of fertilizer and (iv) the effect of continuous application of the ammonium sulphate.

I. *Optimum dose :*

The efficient use of nitrogenous fertilizers varies with the optimum rate, time and method of application. On an average increasing response has been obtained up to 40 lbs. of nitrogen per acre and with further increase in the level of application, the response decreases. With a dose of 20-30 lb. of nitrogen per acre an increase of about 300-500 lbs. of paddy per acre is generally obtained and this dose is considered as the optimum.

II. *Comparative efficiency nitrogenous fertilizers :*

Out of the different forms of nitrogenous fertilizers used, ammonium sulphate has been found to be the most suitable for rice crop. Ammonium chloride, ammonium phosphate, ammonium sulphate-nitrate and urea have also been found to give appreciable increase in yield and could be used as alternative sources of nitrogen,—their extensive use will, however, depend upon their comparative cost and availability. Other fertilizers like calcium ammonium nitrate which can be produced at a cheaper cost are also being tested. Nitrates of sodium and potassium and calcium cyanamide are found inferior to ammonium sulphate. The data obtained show that the ammonical forms of nitrogen are more efficient than the nitrate forms.

III. *The optimum time and method of application of fertilizers :*

In order to get the maximum benefit out of the fertilizers, it is necessary that an efficient and rational method of application is followed. Experiments on time of application and placement of fertilizer have been conducted at Central Rice Research Institute.

(a) *Deep placement of ammonium sulphate :*

The customary method of applying ammonium sulphate to rice crop throughout the country is top-dressing soon after the crop is established. By such method of

application in water-logged rice soils, a considerable amount of nitrogen applied is lost through denitrification taking place in the soil. Results of experiments conducted at Central Rice Research Institute indicate that sub-surface application of ammonium sulphate either as a basal dressing or as top-dressing in the form of pellets is more beneficial than the customary surface application. The yield response obtained with deep placement of 100 lb. of ammonium sulphate is comparable with that of 200 lbs. applied as surface dressing. Thus the efficiency of ammonium sulphate can be considerably increased by deep placement.

Sub-surface application is done in different ways depending upon the prevailing soil and water conditions. In dry soils, ammonium sulphate can be applied two or three inches deep in the plough furrow immediately before letting in water for puddling, while in wet soils, the fertilizers can be well mixed with the soil at the time of puddling the field or placed in the reducing zone in the form of pellets at the time of weeding where it remains stable and gradually become available to the crop during the active vegetative period.

(b) *Fractional application of ammonium sulphate :*

Usually the fertilizers are applied in one dose as top-dressing. Experiments are currently in progress to determine the optimum time of application of ammonium sulphate to rice crop and to see whether the entire quantity should be applied in one dose or in split doses at different stages of plant growth. It has been found that fractional application of ammonium sulphate to supply 40 lb. of N per acre in three doses viz., at planting, one month after planting and at the flowering initiation gives an increase yield of 37-50 per cent while the application of entire quantity in one dose gives an increase of 27 per cent. The time of split dressing of the fertilizers coincides with the active vegetative growth and tillering in the early stages and the flowering initiation at the latter stages when the plant is capable of making the proper use of the fertilizer applied.

Therefore by modifying the method and time of application, the rice yields can be considerably increased.

III. *The effect of continuous application of ammonium sulphate on the soil :*

The ammonium sulphate being an acidic fertilizer, there is some apprehension of its adverse effect on the soil. A series of permanent experiments is in progress to study the effect of continuous application of ammonium sulphate on the soil fertility. Ammonium sulphate in varying doses from 20-80 lbs. of nitrogen per acre is being applied for last ten years on the same field alone as well as in combination with compost and lime. Increasing response was obtained upto 40 lb. N per acre and on equal nitrogen basis ammonium sulphate gave a better response than the compost. After ten years of continuous application of ammonium sulphate no deleterious effects on the soil were noticed. While the ammonium sulphate left no deleterious or beneficial residual effect the compost showed a cumulative effect. Highest yield in the experiment was obtained with application of 100 lbs. of ammonium sulphate in combination with a basal dressing of compost.

The results of the manurial experiments reveal that in most parts of India soil fertility is stabilised at a comparatively low level of fertility and for increasing the production the judicious use of artificial fertilizers is essential. Of all the plant nutrients, nitrogen application gives an appreciable yield response. Before independence, only a limited amount of sulphate of ammonia was produced in the country and the bulk of the fertilizer was imported. In recent years, the local fertilizer production has been greatly increased and it is expected that by end of third five year the country will be self-sufficient in fertilizer requirements. Besides ammonium sulphate, other nitrogenous fertilizers e.g., urea, ammonium chloride, calcium ammonium-nitrate and ammonium sulphate-nitrate will also be produced.

ENVIRONMENTAL PHYSIOLOGY

Section of Physiology

Chairman : DR. A. ROY, Mathura.

1. M. B. SAHASRABUDHE (Bombay) : *Biological effects of ionizing radiations.*

Environmental health hazards from ionizing radiations arise from three main sources : (i) cosmic radiations, (ii) radiations from naturally occurring radioisotopes and (iii) radiations from manmade sources of radioactivity. The third type of radiation has increased many fold in recent years due to indiscriminate experimental atomic detonations and rapid expansion of atomic energy development programme. Radiation effects are caused by external sources or by accidental ingestion of the radioactive material. To avoid the latter it is necessary to know the ecological movement of radioactive material from one species to another. A brief reference will be made regarding the importance of radio-ecological studies of environmental factors. Experiments carried out in this laboratory to detoxicate and eliminate the ingested radioelements from the body will be discussed.

Radiation effects usually manifest in derangement of haemopoietic system, damage to gastrointestinal tract, impairment of central nervous system and ultimately death of the subject depending on the dose received. Long term effects of radiation exposures are acceleration of the ageing process and induction of various types of malignancies. In order to understand the mechanism of these changes it is necessary to know not only the primary effects of radiation but also the derangement in the various metabolic processes that ultimately lead to radiation sickness and death. This has been investigated in this laboratory. Results of these experiments and also the attempts at modifying the radiation injury will be discussed.

2. P. N. KRISHNAMOORTHY (Bombay) : *Measures to minimise radiation hazards.*

The various types of radiation hazards arising from the widespread and ever increasing use of radiation sources in many fields will be discussed. The various methods adopted to minimise these hazards will be outlined in brief. Reference will also be made to the work of international and national bodies in this field.

3. D. N. MULLICK (Izatnagar) : *Environmental physiology with special reference to the metabolism of nutrients in the farm animals.*

In the homeotherms, adjustment to climatic stress (heat) is closely associated with the metabolism of nutrients. These are usually considered to be functions of body size, metabolic rates or some specific metabolic aspects. How these relationships can be disturbed by the impact of climatic stress require thorough scientific study.

A series of investigation has been undertaken on the metabolic behaviours of different nutrients in cattle, buffalo, sheep and goat, under natural variations of the atmospheric conditions prevailing at the place which is situated at 28° 20' north of Equator and 79° 25' east of the Prime Meridian. Digestibility trials were conducted on these animals at the highest and lowest air temperatures. The highest and lowest temperatures are generally 105° and 60°F respectively. The feeds, urine and faeces were chemically analysed for proximate principles and inorganic elements. From these values, the intake, coefficients of digestion of the organic materials and balances of the inorganic elements including nitrogen were calculated.

The recorded results showed that the experimental animals of all species voluntarily ingested lesser amounts of oil cakes containing protein and fat at higher air temperature. On the other hand, they preferred to take more roughage during this period. The values of the digestibility coefficients of protein and fat were lower in summer months in comparison to winter. Similarly owing to the lesser ingestion of oil cakes at higher air temperature, nitrogen, calcium and phosphorus also showed negative balances.

It may be concluded that the dietary wisdom of the animals to climatic stress coupled with lower ingestion of feeds containing fats and protein and higher consumption of roughage, would necessarily warrant that the animals should be supplied with roughage of better nutritive value like hay and silage instead of cereal straws in order to maintain the productive level under tropical conditions.

4. D. P. SADHU (Calcutta) : *Correlation between surface area, basal and resting metabolism and tissue Q_{O_2} .*

Surface area of goats was measured by a surface integrator. The surface area in square metre was 0.10 weight in kg. raised to the power 0.656. The value of "r" was 0.958 and the value of 'F' in analysis of variance was 243.9. The surface area was correlated to different types of linear measurements. The oxygen consumption was measured by Benedict-Roth apparatus and also by Haldane gas analysis apparatus to determine the methane value of expired air. The basal metabolism in calories per 24 hrs. was 69.47 times the weight in kg. raised to the power 0.74 and the resting metabolism was 170.8 times the weight in kg. raised to the power 0.63. To determine the active mass of protoplasm, the oxygen consumption of different tissues such as liver, kidney and brain was determined and this is also related to the basal metabolism.

5. K. K. GUPTA (New Delhi) : *Effects of environments and altitude on blood cholesterol and coronary circulation.*

Recently a study was undertaken in which the serum cholesterol levels in 70 healthy persons who had lived at an altitude of 7,200 ft. for at least 2 years, was compared to that of persons of similar age groups who had lived at sea level. It was found that the mean value of serum cholesterol was higher in the former groups. From the results of these experiments it was concluded that altitude has a definite effect upon the serum cholesterol level. It was further postulated that the increase in haemoglobin which occurs at high altitude is accompanied by an increase in degenerated ghost cells which contribute cholesterol to the serum. The authors conclude that the effect of altitude on serum cholesterol deserves the serious attention of investigators in the field of lipid metabolism.

As regards the effect of the cold, it has been shown that in rats exposed to cold, a higher incidence of fat deposition in the coronary arteries was shown even when they were fed on rations supplemented with lipotropic factors like choline. These experimental studies have been further corroborated by the geographic incidence of this disease in different parts of the world.

Following changes during gradual decompression have been noticed :

Phase 1. Upto 15,000 ft. : (1) Increase in heart rate. (2) Elevation of P wave (3) Shortening of PR interval. (4) QRS voltage progressive decrease. (5) T-wave-progressive depression

Phase 2. In between 20,000/25,000 ft. : (1) Sudden decrease of heart rate due to SA—AV block. (2) Depression of P-wave. (3) P-R interval remains shortened. (4) QRS voltage may increase. (5) Depression of RST and partial inversion of T.

Phase 3. Above 25,000 ft. : (1) Progressive slowing of heart rate, appearance of arrhythmia and finally ventricular fibrillation. (2) Inversion of P wave. (3) P-R interval shows marked prolongation. (4) QRS voltage may increase. (5) Depression of RST and partial inversion of T.

6. M. N. GUPTA (New Delhi) : *Environmental conditions in factories and mines with special reference to hazardous dusts.*

An industrialisation and urbanisation advance in India, health and comfort conditions will call for special consideration and assume greater importance. Better environmental conditions are inextricably bound up with the problem of dust (pneumoconiosis incidence), comfort (fatigue and workers resistance to respiratory illness) and productivity (national wealth).

The material presented has been gathered from medical and environmental hygiene surveys carried out by the Chief Adviser Factories Organisation in mines (mica, manganese and coal) and factories (metal grinding, refractories manufacture, pottery and ceramic works, accumulator industry and cement manufacture).

The chemical and physical characteristics of the dusts, their composition and particle size, concentration of particles in the atmosphere breathed and the duration of exposure all play an important part.

Incidence of silicosis in silica risk industries and pneumoconiosis in coal mining and coal trimming are presented along with tuberculosis incidence to assess the health of each industry.

In relation to human comfort and increased productivity, provision of adequate ventilation and temperature conditions which have always been and remain a *sine qua non* of successful industrialisation, the data gathered on these aspects in coal mining and textile industry are presented.

Research studies and control of working environment by doctors, physiologists, engineers, chemists, physicists, hygienists etc., working in a team is stressed.

7 J. R. SEN (Jamshedpur) : *Physical environmental factors around modern blast furnaces and their effects on human physiology.*

The effects of the physical environments around blast furnaces (e.g., industrial dust, gas and temperature) on various aspects of human physiology—defensive mechanisms of the body and preventive measures against the adverse effects of these environmental factors have been studied. The important physical environmental factors are :

- (i) Dust clouds from iron ore, lime stone etc., and coke breeze.
- (ii) Blast furnace gas—its effects.
- (iii) Effects of thermal environment.

Industrial dust : Definition—intrinsic defensive mechanisms of the human system against dust—reaction of certain important dust (silica) on the respiratory system and its ultimate effect—dust counting apparatus and permissible dustiness in a working environment—preventive measures.

Blast furnace gas : Its physiological importance—the percentage of carbonmonoxide in the blast furnace gas—the effects of inhalation of carbonmonoxide of various durations of exposure in various concentrations—elimination of carbonmonoxide—alleged chronic poisoning—carbonmonoxide detectors—preventive measures.

Thermal environment—Its constituents—air temperature—humidity—rate of movement of the air—radiation temperature—corrected effective temperature—its

range in relation to human comfort etc.—its effects on human system—preventive measures.

8. U. P. BASU (Calcutta) : *Environmental factors in chemical industry.*

India is going to industrialize herself rapidly, and for this different unit operations and large scale production and distribution of chemicals would be involved. Most of chemicals constitute potential health hazard and they may cause physiological disorders of diverse degree. In order to ensure the safety of the workers as well as to enhance the productivity so essential for rapid industrial expansion, informations on the physiological changes caused by one or other chemical process work under Indian conditions would be of considerable significance.

In the body of this paper the effect on the skin by several organic compounds (dinitrochlorobenzene, dinitrotoluene, dinitrobenzoic acid, dichloroquinoline, trichloroethylene) required for certain industrial operation during the preparation of well known synthetic drugs like aminoacridine, mepacrine, chloroquin, isoniazid, has been described. It also contains a brief description of the occurrence of hay fever during handling of certain mold power. The importance of recording of these phenomena for further expansion of industries as well as for widening of the profession of science has been discussed.

9. A. SENGUPTA (Calcutta) : *Human performance under thermal stress.*

Steady performance of human machine ensures the output of energy which manifests itself in mechanical work. The pre-requisites for such an organisation are chiefly : (1) uniform supply of oxygen to working muscles through blood circulation and (2) maintenance of optimal condition (specially temperature) for biochemical reactions to continue. Evaluation of physiological responses, like pulse rate, rectal temperature, sweat rate during work throws light on the nature of organisation prevailing thereon.

In hot dry environments, to satisfy the above two conditions during muscular work becomes increasingly difficult. Heat produced by excess metabolism in work can only be lost to environment through evaporation, other channels of loss acting in a reverse manner. This naturally puts a great strain on the body on regulation of water balance, often ending in dehydration which limits the human performance in hot dry climate. In a typical hot dry climate, dehydration by absence of drinking while working, resulted in elevation of pulse rate, rectal temperature and water loss to undesirable levels which could be prevented by drinking pure water even in excess. Saline drinking did not improve the response to the level of pure water drinking.

In wet heat, the incapacitation of performance is due to hyperthermia. This syndrome itself is responsible to produce other dysfunctions which follow. Excess loss of water in sweat due to high rectal and skin temperature accompanied by a moderate salt loss result in cramps which limits the endurance. In such conditions, the body cannot derive full benefit from thermal sweating in evaporative cooling because of dripping of sweat from the body without vapourisation. Experiments performed during steady state conditions of work is evaluated to point at the straining of responded due to above mentioned causes.

The complete picture of thermal stress on human organism is only complete when sufficient attention is paid to the alteration of body fluids in between the compartments of the body. A short discussion on the nature of such an alteration is appended for a better understanding of the whole problem.

10. S. BANERJI (Bikaner) : *Energy cost of different activities of persons working under different environmental conditions in different occupations.*

Energy expenditures of persons under different occupations and working under different environmental conditions have been determined by collecting expired air in a K.M. Respirometer and analysing the air for oxygen and carbon dioxide with a Haldane-Henderson-Baily gas analysis apparatus. The persons under different occupations studied were laboratory workers, workers in a spinning and weaving mill and rickshaw pullers of Calcutta. Total energy expenditure of persons of the different occupations studied varied greatly. The same activity like lying rest, sitting rest, standing rest, sitting work, walking etc. of the persons under the different groups also varied greatly. Explanations for the different results would be discussed in the symposium.

11. S. R. MAITRA (Calcutta) : *Work and environment.*

The physical work causes physical changes in the body by increasing the heart rate to increase blood flow which meets the increased O_2 demand for the work and by increasing the respiratory rate and depth to give access to more O_2 to blood of the lungs. Along with these changes the concentration in blood of protein, cell volume and Hb also changes and these changes have got some relation with the intensity of work. Along with these changes the temperature of the body gradually rises and it causes sweating which depends on duration of work and its intensity, and is produced to keep the body temperature within physiological limit. When there will be physical work along with high environmental temperature more heat will be produced in the body than with only the physical work or high environmental temperature. As the body will maintain the physiological limit of heat balance less work will be done if the environmental temperature remains high or environmental temperature will have to be lowered down to maintain the increased amount of physical work. This principle requires elucidation in quantitative terms. Increased humidity further complicates the effect of higher environmental temperature. Furthermore, different age groups act differently to produce vasodilation at same high temperature. They have also reported that onset of sweating time is less in younger group than in the older one. These physiological variation according to age will also make difference in heat transference. This requires further elucidation in our country to find out how far the biological variation is there between people of tropical country and cold country.

Altitude and work : Knowledge on physical working capacity, fatigue and development of adjustability with time in different altitudes is not as yet clear. Due to mountainous border of India more detailed knowledge on this subject is needed.

Industry and work : Working arrangement in industries besides the temperature of the room has got other environmental characteristics. The work here can be physical or mental. Lehman of Max Planck Institute of Arbeits Physiologie in West Germany suggested 2,500 K. calori as basal requirement and 2,000 K. calori to be utilized for work for an adult man. If work is done for eight hours in a day and 2,000 K. calories of work to be done in 8 hours, then the intensity of work per minute on an average is 4.2 K. calori. If the nature of work in the industry is more intensive than the average, definite rest pauses should be given to keep the total work to 2,000 K. calori. In these intensive work fatigue allowance is given. If there is stress in the environment like high environmental temperature as in summer in India or radiant heat, i.e., if the work is done under sun or near blast furnaces of the steel works etc. this fatigue allowance should be further increased.

Lighting, noise and vibration beyond the comfort limit enhance fatigue.

Radio-active radiation, dust and toxic hazards do cause harm by bringing specific disease but do not interfere directly with working efficiency.

I. TRADITIONAL INDIAN PSYCHOLOGICAL CONCEPTS

Section of Psychology & Educational Sciences

Chairman : D. GANGULY, Calcutta.

1. H. N. BANERJEE (Rajasthan) : *Traditional Psychological Concepts and Parapsychology.*

Psychology started on its eventful career with a determination to understand scientifically the entire nature of man. Many ordeals came before it, chief among them were certain unscientific assumptions which had gathered round the subject in the name of traditional wisdom. In order to make psychology an exact science Psychologists started using observation and experiment and neglected introspective way of knowing things. Introduction of scientific methods made Psychology exact to some extent and made it a regular member of science. But the introduction of these methods prevented them from considering the merits of certain psychological concepts which were formulated by thoughtful persons of the past by their purified introspection. So, if we have to find out the real value of traditional psychological concepts, the process of forming concepts should be examined in the light of introspection and observation.

Process of Forming Concepts according to Western Psychology.

According to Murphy, "a concept is a symbol which stands for a specific quality possessed in common by a number of stimuli." This symbol is formed by finding common factors in different items of impressions. So concepts are the results of observation. But the process of observation is determined by the ingrained mental disposition of the observer which dictates the observer—what to see and what not to see. Perfect observation is not possible unless understanding is purified by rigid mental training. Unless the observation is perfected scientific data cannot be collected.

Indian Way of Forming Concepts.

Psychologists of India considered that before passing any psychological judgment, mind should be developed by proper training. Patanjali in his Yoga-sutras has given Yogic techniques which are supposed to make man's mind perfectly impartial and free from all limitations even from the laws of time and space. According to him a Yogi can know and experience things and objective events without coming into contact with them. At such a stage of mental developments he can form concepts introspectively.

Experimental position of the Stand of Ancient Indian Psychologists.

Indian psychologists of the past maintained that human mind at a particular stage of development can apprehend things without actually experiencing them, so it can form perfectly objective concepts introspectively also at that stage.

Parapsychology has experimentally established that human mind has the potentiality to work independently of the limitations of time and space. In this way the new subject has indirectly supported the stand point of ancient Indian Psychologist that concepts can be formed introspectively also.

2. UDAI PARREK (New Delhi) : *The Problem of Methodology of Studying Psychological Concepts of Ancient India.*

In India we have a rich tradition of philosophy containing in embryonic form the elements of the various social and physical sciences. During the evolution of

the various forms of the society in India, rudimental beginnings were made in the various sciences. However, unfortunately because of the long gap of time and the mystic nature of the sources available for study, it is not possible to re-construct the history of Indian thought in a scientific way. The usual practice has been to build up a system of Indian philosophy or psychology on the basis of the commentaries which we get from much later sources. This has resulted in confusion and the interpretations quite often are far from being scientific.

It is necessary to work out detailed methodology of studying the concepts of psychology imbedded in the ancient Indian literature and philosophy. For this purpose it would be useful to proceed on the assumption that consciousness is the product of social reality. The various concepts in a particular age develop as a result of the material conditions prevalent in that age. If the psychological concepts in ancient India are studied by taking into consideration the material life prevalent at that time they can be understood in a more scientific way. Unfortunately, no efforts have been made in this direction. The recent publication of Chattopadhyaya's *Lokayat* shows how such a line of study can prove to be useful.

While re-constructing ancient Indian concepts of psychology it would be necessary to proceed on certain scientific assumptions. The two important assumptions which are basic in this respect are about the uneven development of Indian society and the tribal survival found in our country. Various communities in the society existed at the various stages of development and the ritual practices prevalent in the ancient tribes filtered down to the later societies and are preserved in them.

It would be necessary for understanding properly the psychological concepts of ancient India to try to reconstruct the nature of material reality and the form of social development prevalent at that time.

It would also be necessary to make thorough studies of the psychological concepts prevalent in certain tribes found in our country which are living at the various stages of evolution corresponding to those that were prevalent in the various epochs in India. Such socio-anthropo-psychological studies may prove useful for this purpose.

Sociological studies may also throw light on the psychological concepts prevalent in a particular age. For this purpose details may have to be worked out regarding the characteristics of the various stages of evolution of human society. It may, for example, be useful to discuss whether the thesis put forward by Chattopadhyaya that agricultural community are matriarchal and pastoral patriarchal in form.

The usefulness of this adoption of such methodology may be illustrated by taking examples of the evolution of 'Tantarism' and the original 'Sankhya' system of thought in ancient India.

II. SELECTION OF TECHNICAL PERSONNEL

Chairman : D. GANGULY, Calcutta.

1. DR. RHEA S. DAS (Calcutta) : *Selection of Technical Personnel.*

For more effective utilisation of technical personnel in India's development, a programme coordinating assessment of manpower needs and resources with personnel selection policies and methods may be proposed. While industries are crying for technical personnel, technically qualified individuals are unemployed or employed where they cannot utilise their training and knowledge to help the country. Through an assessment of technical manpower needs and resources, it should be possible to indicate, for various areas of technical specialisation, where

personnel selection or personnel placement procedures are appropriate. Further, a system of priorities can be set up permitting research into and development of selection and placement techniques where they are most needed. By means of research, quantitative selection and placement techniques can be developed in terms of the criteria of reliability, validity, and statistically effective discrimination and classification of individuals. With these techniques, the costs of poor placement and selection, to both the country and individuals concerned, can be reduced.

A partial list of activities subsumed under this programme coordinating assessment of manpower needs and resources with personnel selection research includes the following :

- (i) Assessment of present and expected manpower needs for different categories of technical specialization, along the lines carried out by the Planning Commission;
- (ii) Assessment of present and expected manpower resources, using information from the National Register of Scientific and Technical Personnel, the Employment Exchanges, and from the universities, technical and professional institutions;
- (iii) For the different categories of technical personnel, determining the ratio of resources to needs, which will in turn indicate whether the personnel problem is one of selection or placement, and ordering the categories in terms of priority;
- (iv) On the basis of job description, worker analysis and critical incidents, development of appropriate selection and placement psychometric tests of ability and achievement, indices of job related behaviour, and quantitative interview methods; and
- (v) Statistical demonstration of the reliability, validity, and capacity to effectively discriminate and classify individuals, of these selection and placement techniques.

This programme would require high-level policy decisions, and close collaboration of statisticians and psychologists. The expected advantages of the approach would be that quantitative selection and placement techniques would be available where needed, and the effectiveness of those techniques in reducing costs due to wasteful placement and selection of technical manpower could be demonstrated.

2. DR. BIMALESWAR DE (Muzaffarpur) : *Selection of Technical Personnel.*

Its Rationale : The primary aim of personnel selection is to select from a number of applicants for a job, those applicants who will be most successful in it. This selection is also a prediction about the future efficiency of the selected persons. The efficiency of any service-organisation is dependent, among other factors, mainly on the quality of its personnel. Selection of efficient personnel, therefore, is of the highest importance. Quality of selection, in its turn, depends on the quality of the selection procedures. Both are interlinked.

Its present status in India : The selection procedures at present followed in India by different selecting bodies include interview, written and physical tests. The pattern, with slight variations, is cast in the same mould. Their efficiency, objectivity and predictive value are not known. But these qualities should characterise any selection procedure worth its name.

The present status of the psychology of personnel selection : The psychology of personnel selection has now advanced to the stage when it can offer more dependable and objective methods than are employed by different services for recruitment of their personnel. These techniques which have been developed after intensive researches in different areas like the military, civil, industry etc., in countries like U.K. and U.S.A., combine traditional methods with new ones. They

improve the existing selection methods by providing more information about the candidates and by assessing the predictive value of selection. The two types of selection methods which are being used at present in industry and civil services in U.K. are, (i) paper and pencil tests, and (ii) selection boards, known as the 'new-type selection boards'. In this connection, the recommendations made in a survey of selection procedures in U.K. (vide *Sankhya*, Vol. 17, Part 4, Feb. '57), are worth considering. "Both types of selection procedures (mentioned above) have applicability in India. The paper and pencil test is recommended for economy, and for non-administrative personnel selection. The selection board is recommended where policy-making, leadership personal contact and group co-operation are important. Starting with careful job analysis, these techniques may be modified to achieve greater cultural meaning and to provide more standard assessments.

Our urgent need: The absence of a central research unit for planning and implementing a long-range research programme, among other fields, in personnel selection, is a great handicap for Indian psychologists. Besides its activities in the operational level, such a unit will also supply trained personnel to cope with the specialised work of personnel selection. Setting up such an agency, therefore, should be given top priority in the present context of India's ever growing development programmes.

3. DR. S. P. GHOSH (Delhi) : *Selection of technical personnel.*

The procedure of selection of technical personnel by the application of psycho-technical tests involves the following steps :—

- (i) The job and worker analysis to determine the essential qualities needed for executing the job successfully; and preparation of a job-psychograph presenting the key-stone qualities.
- (ii) On the basis of the job-psychograph a battery of psycho-technical tests is to be chosen for measuring the key-stone qualities; and it is to be applied upon a group of experienced workers.
- (iii) The test-scores thus obtained are to be validated against the criterion of output or supervisors' ratings; and the final battery is to be constructed by the Wherry Doolittle test selection method of multiple correlation.
- (iv) The final prediction formula is to be prepared by taking the Regression co-efficients as weights of the tests.
- (v) The test battery thus prepared will be applied upon the applicants and scores are to be arranged in order of merit; and the requisite number is to be selected from the top.

The above procedure of selection as done by the application of psycho-technical tests may be supplemented by an objective interview. The objective interview apart from its precision as a scientific tool, gives some sense of satisfaction to the top-ranking people of the management. They feel, they have seen and selected the workers who will work under them.

III. PSYCHOLOGICAL FACTORS IN NATIONAL INTEGRATION

Chairman : D. GANGULY, Calcutta.

1. ADARSH KHANNA (New Delhi) : *The Problem of National Integration and the Role of Psychologists.*

The concept of national integration has to be understood in its proper perspective in our country. National integration should not mean developing uniform

ways of life, language and thinking. If conceived in that sense, which is often done, it may degenerate into facism of language, thinking and culture. We cannot have, and should not conceive of having, one pattern of thinking or cultural form in the country. The concept of national integration should give rise to the idea of developing a distinct personality of Indian man. This has got to be done in the background of our cultural heritage and the set of values imbibed by us from the past.

National integration in the present context of the country should be taken to mean the proper adjustment of the citizens of the country to the new modes of life which are being developed in our society. Vast social, economic, and consequently psychological, changes are taking place in the country. A new social order is emerging. It is necessary to see that the citizens of the country are able to adjust themselves to these changes and, as a result of this, a new type of citizen should emerge.

National integration in this sense would have 2 aspects; prevention of disintegration and building up of integration. We have to attend to both these aspects.

Psychologists have to play a vital role in bringing about integration in the country. The psychologists can do this through various ways. In the first place, it would be necessary to analyse the causes of disintegration. Disintegration is taking place rapidly at two levels: at the level of the individual and at the level of the group life. In the latter we may include various kinds of primary and secondary groups. The causes have to be found out and measures have to be taken to prevent this rapidly developing disintegration.

Psychologists can also help in the emergence of new groups and of new leadership in the developing society. With the breaking of the old structure of group life in the country, it would be necessary to substitute a pattern of new groups and to develop new democratic leadership in the country. Through such a process we can ensure national integration.

Psychologists can also help in the development of new sentiments conforming to the new socialistic social order emerging in our country. The old pattern of sentiments is incompatible with the new order. This demands a new pattern.

The greatest contribution that psychologists can make is in the rehabilitation of the ego-involvements of the people. With the breaking of the old pattern, people's faith and interests have been shaken. It is necessary to rehabilitate their faith by making them ego-involved in new programmes of development. This would go a long way in removing the apathy of people towards the various projects.

The problem of fighting against prejudices, old and new, is of vital necessity. Psychologists can help the problem of national integration by probing into the dynamics of prejudices and creation of stereotypes, and by suggesting means to fight against them.

In short, psychologists can play a vital role in bringing about national integration in the country. The role of psychologists, however, should not be confined to that of technicians only. They have also to play the role of social philosophers by understanding the process of the social change and by assisting in bringing about that process. Psychologists should not merely try to understand and interpret new social order but should be able to bring about desirable change in it. Thereby national integration can be ensured.

2. DR. V. K. ALEXANDER (Kerala): *Some Psychological Factors in National Integration.*

One of the most important needs of modern India is to have an emotional integration of all its nationals. How to cultivate this emotional integration is the problem, we Psychologists have to face and find an answer. Though Social

Psychology is a well-developed Science, it has not given us enough data concerning the basic factors that underlie the forces that bind people together into a group or a nation. Freud and McDougall have postulated their own theories, but these theories are not experimentally verified. But one can find a common factor in all of them and that is the emotional factor.

One of the ways by which we can achieve this emotional integration is to make use of the experimentally verified factor in the development of Attitude. Research studies have shown that attitude is something we learn from our parents and neighbourhood. Hence by controlling the variables involved in learning, we can control to some extent the growth and development of emotional integration of our people.

One of the suggestions is to make full use of the National Festivals. National Festivals stimulate pleasant emotions and making them as exciting and attractive as possible we can stimulate the growth of this attitude towards our country. Though at present, we have some of the National Festivals where our people take keen interest, we have to help the National Leaders to draw up the programmes with this end in view, i.e., the integration of all our emotions centred around our country. With the knowledge of the theories of learning and an insight into the growth and development of Attitudes, we may be able to help our National Leaders to achieve this end.

I. ELECTRONIC INSTRUMENTS

Section of Engineering & Metallurgy

Chairman : PROF. N. N. SEN, Calcutta.

Electronics has established for itself a very important place in almost every field of science and technology and I sincerely believe that this Symposium will go a long way to enable us to take stock of our position in the very important field of Electronic Instruments. Under the auspices of the Indian Science Congress Association a symposium on Electronics in Industry was held in 1947 in the Physics Section and you all know that since then considerable information about the inconceivable progress made in the domain of Electronics during the last World War has been available. These have been followed up by even greater developments during the post War period and therefore the present symposium has been very opportune.

I may recall in this connection that in the early days electronics was confined to the field of entertainment and communication but the boundaries of the domain of electronics have expanded to such an extent that it is really difficult to define electronics to-day. The electron microscope, the infra-red sniperscope and many other infra-red devices, the radio telescope, radar and television have increased the range of human vision. The electronic computer has multiplied man's brain power. Electronic control and safety devices have become indispensable in modern Industry; in many spheres automation has already proved very useful. The achievements of Electronics in the present Missile age have been so exciting that people are now looking upon electronics as capable of doing jobs which cannot normally be done by known scientific and engineering means. Electronic instruments and automation systems can think faster and are capable of greater degree of accuracy in judgment than a man. Electronic machines can detect their own errors and correct themselves, a feature not always expected of a human being.

For quantitative measurement of a very small quantity, irrespective of its nature, electronic methods are essential. For other measurements, such as for example, velocity of an earth satellite or space rocket, for detecting metals under-

ground, for manoeuvring bombers without pilots, for remote controlled reconnaissance aircrafts carrying electronic instruments for taking photographs and transmitting them and also other information by special television system, for diagnosis of brain diseases, location of brain tumors, bloodless surgery and for various other complicated work, electronics is the only solution.

I don't think it is necessary for me, and I am not really competent either, to describe the various electronic instruments that have been developed so far for scientific research and for applications in modern industry. I would only draw your attention to a few instruments which are perhaps not so well known to the average engineer.

Ultrasonic waves have for sometime past been successfully used for many non-destructive tests such as flaw detection in materials, for measuring sea depths by echo sounding, for hastening of chemical and biological reactions, for pasteurising milk, for separation or precipitation of emulsions continue to be used increasingly in industry. The ultrasonic soldering iron is a typical example. When light metals like aluminium are exposed to air, a thin layer of inert oxides is immediately formed which renders ordinary tinning impossible. When, however, the molten solder on the surface is given a vigorous shaking by a rod vibrating at a supersonic rate, vapour-filled cavities are continuously formed which collapse violently on the oxide layer. This destroys the oxide layer and renders tinning easy. The ultrasonic drill is another example. Normally a drill cannot make a hole which is not circular but the ultrasonic drill gives tiny blows at a supersonic rate with a reciprocating tip and can thus cut holes of any shape, and quickly too, even in such materials like glass.

Electronic instruments based on the use of infra-red rays, some of which were developed during the Second World War, are assuming greater and greater importance with increasing possibilities of night operations in a future war. The instruments developed during the war were of the active type, i.e. an infrared search-light illuminated the targets and the reflected or scattered radiations were picked up by suitable detectors. The modern trend is towards passive systems requiring no artificial infrared radiator. A recent development in the U.S.A. is the Thermograph in which a fluorescent screen at the receiver is made luminous by irradiation with ultraviolet light. When infrared light from the target is focussed on this screen the glow is quenched to a greater or lesser extent and thus a shadow picture is produced. Infrared television systems have also been developed recently. Infrared aircraft landing instruments are also being developed to replace the conventional bulky radars.

While discussing the recent trends in electronic instruments I cannot but refer to the variety of devices using semi-conductors like the transistor. It was more or less a laboratory curiosity about ten years ago but by now its use has been so widespread and successful that it is difficult to foresee its potentialities. Apart from the transistor and related devices there are other electronically active solids which also deserve special mention. One very useful application of semiconductors, developed recently, is in conversion of solar energy. A battery of silicon photodiodes has, for example, been used effectively for converting solar energy into electrical energy with an efficiency of about 10%. Again, the heart of the solid-state MASER is a single crystal of carefully controlled composition, containing a small but essential amount of impurity. You may perhaps know that the MASER—abbreviation of Microwave Amplification with Stimulated Emission of Radiation—enabled the radar apparatus at MIT to contact Venus at an operating frequency of about 440 megacycles/sec. The maser, because of its inherent low noise, has immense potentialities for radio astronomy and in tracking satellites, missiles and space vehicles at long ranges.

In conclusion, I cannot but refer to the outstanding difficulties which we face in regard to development and use of electronic instruments. It has become almost

impossible to procure special components and valves. I have heard responsible workers expressing the regret that many specialised and costly electronic instruments may soon lie idle because of want of suitable spare parts and you all know that deterioration of electronic instruments is a regenerative process. If an electronic instrument is not used for some time it will automatically develop more faults and will soon be completely out of use. I therefore feel that Government should take immediate steps to make up this deficiency and mobilise all possible efforts to overcome this difficulty. If necessary, a team of experts in this field should make a survey of the electronic instruments available in the various institutions and establishments in our country and advise the Government as to how these may be kept running. We must certainly do our utmost to manufacture as many parts as are possible with the present available facilities but at the same time shall have to import items which cannot be made in India. The same team of experts may also visit some selected manufacturing organisations abroad with a view to exploring possibilities and finding out ways and means to make India independent of foreign import as quickly as possible.

2. PARANANDI VENKATA SURYANARAYANA RAO (Bombay).

A brief description of the principles and salient features of the Electronic Digital Computes that was assembled in the Tata Institute of Fundamental Research. The computes can be divided into four main parts.

- (1) Arithmetic Unit where calculations are done.
- (2) Memory where numbers and instructions are stored.
- (3) Control which governs the information flow.
- and (4) The input and output unit which is a means of communication with the external world.

The developments done here are

- (1) A fast adder which minimises carry delay by means of a carry by pass circuit.
- (2) A shift counter where the setting up time is minimum and independent of the number of stages.
- (3) A Cathode Ray Display unit for fast display of characters and numbers (outputs of the computer) on a memotron tube.
- (4) Magnetic drum as an auxiliary memory unit.

3. DR. S. S. BANERJEE (Banaras).

The necessity for the development of Electronic Instruments has been felt almost simultaneously with the growth of electronic techniques in the field of Science and Engineering. In the present age there is hardly any scientific investigation which is not associated with the application of electronics. The efficiency of industry has been highly increased by electronic control. Electronic devices are being increasingly used in medicine. The advent of transistors has opened a new avenue and vast possibilities in the development of electronic instruments and they may bring revolutionary changes in the design of such instruments. Electronic instruments can now be used not only for the functions and control of machines but also for human functions of detection and control.

The advancement of science and technology has necessitated a rapid growth in the technique of measurement. Various new instruments have been developed for new applications in different branches of science. The most important developments have however been made in the electronic instruments which in several cases depend on their performance of amplifying small d.c. voltages originating

either from a thermo-couple or from a sensitive detector. The d.c. voltages are generally developed due to the passage of small current flowing through high resistances and thus the necessity arises for high input resistances of such amplifiers, which has been obtained with the help of electrometer tubes. Such tubes are particularly suitable for the measurement of small currents from ionization chambers which are useful in nuclear physics.

Coming to another very common and useful instrument, cathode ray oscillograph, it may be mentioned that very high deflection sensitivity and high writing speed have now been obtained by the introduction of an accelerating field applied after the deflecting plates. The high sensitivity of these tubes very much simplifies the design of amplifiers associated with such instruments and has made them suitable for transient measurements. The linearity of the time-base circuits in such instruments has also highly improved with the help of associated networks in the equipment.

Electronic phase meters have been developed for the measurement of phase angle at high frequencies which are useful in measuring the angle of the down-coming radio waves from the ionosphere. This meter uses a rectifier which measures rectified current due to the signals of equal voltages differing in phase applied to the rectifier. Such voltages may be obtained either from variable gain amplifier or from the receiving aerials directly, erected for the angle measurement.

Electronic wattmeters have now been developed which can measure fairly high power by proper selection of valves. Small time intervals and frequencies can be measured with precision by means of electronic devices. These are only a few examples to quote, but it may be mentioned that the electronic instruments have been developed for various types of measurements which may be either of highly specialised type or for common use. Finally, it may be added that the progress of research in this direction amply suggests that further developments in the electronic instruments will be made which will make them more economic, accurate, reliable and portable with the help of transistors.

II FUTURE TREND REGARDING UTILISATION OF FUEL (INCLUDING NUCLEAR FUEL) FOR POWER GENERATION

Chairman : PROF. N. N. SEN, Calcutta.

DR. H. J. BHABHA :

Dr. Bhabha in opening the discussion stressed the need for adequate supply of energy in the development of any country, whether in the field of agriculture or industry. Electrical power is an important source of energy and there is no doubt that in the future, nuclear power will have to play a vital role in the development of our country.

Coming to the cost of power, he pointed out that this was made up of two parts, firstly the fuel cost and secondly the fixed charges. For regions remote from the coal-fields, the cost of coal varies from Rs. 48/ton of 10,000 BTU/lb. to Rs. 45/ton of 9,000 BTU/lb. The fuel cost in such regions in the case of power derived from coal would vary from 2.47 to 2.58 nP/kwh respectively. Against these the nuclear fuel cost, varies from 1.16 to 1.65 nP/kwh. on the basis of uranium fuel element costs varying from Rs. 3 lakhs to Rs. 4 lakhs per tonne. Fixed charges, however, in the case of nuclear power are in excess of those for coal; 1.87 nP/kwh for nuclear power station, as against .84 nP/kwh for a coal fired power station. Adding the cost of operation and maintenance charges the total cost of nuclear power would vary from 3.43 to 3.99 nP/kwh against the cost of power from coal in regions remote from the coal-fields of 3.49 to 3.6 nP/kwh.

Thus the total cost of power in both cases is comparable though in the case of nuclear power the running expenses are much cheaper.

In reply to a question, he mentioned that in both the cases he had assumed 80% L.F. and that the cost of power from coal is based on the assumptions made by the CWPC. He pointed out that a distinction had to be made between the load factor of the system as a whole and the load factor of a particular station in the grid. The former was often 60%, and sometimes as low as 40%, while the latter could be as high as 80% in the same grid.

Sri M. N. Chakravarti, in supplementing the opening remarks of Dr. Bhabha, added that by 1986, the electrical power requirements of India should have exceeded 50 million kilowatts of installed capacity, and a great deal of thought had been given to this matter of meeting this demand.

The potential hydro capacity of the country is about 43 million kilowatts but a large part of this is located in the upper reaches of the Himalayas, in Nepal and Assam, where the demand for power is not likely to be great. A fair proportion is also located in the coal belt where apparently low grades of coal or middlings could be used, instead of developing expensive hydro power. He estimated that in 25 years time, not more than half of this potential could be harnessed for generation of power.

He referred to the speech of Mr. Singh and agreed with him that the coal reserves in the country are limited, and it is not likely that that coal would be able to account for more than 10 to 12 million kilowatts of capacity. Further, every one million kilowatt of power at 66%, L.F., entails the transportation of 3.3 million tons of coal, raising a stupendous transportation problem in areas where the electricity produced would go to encourage industry.

With about 20-25 million kilowatts of hydro power and 10 to 12 million kilowatts of power from coal, there would still remain a wide gap and, as far as can be seen, a large part of this had to be met by nuclear power. In this connection he added that India was rich in thorium and consequently our programme would have to be in stages and, therefore, a beginning in a big way has to be made even now.

He explained that these factors were being placed before the meeting in order to enable them to appreciate that in the present context the relative power cost need not be the major consideration; he repeated what Dr. Bhabha had explained, that the cost of power generated from coal and from nuclear sources was of the same order. There is, therefore, a strong case for accelerating the nuclear power programme.

SRI R. N. GANGULY, Calcutta.

The cost of an atomic power station is about 175-200% of the cost of conventional thermal power station. The capital cost thus becomes prohibitive as it badly reflects on cost of unit generated even if we assume a decent life of twenty years for reactors. The cost is bound to come down to a much lower figure in near future when reactors with smaller core, cheap moderator and efficient coolant system could be effectively designed.

Comparative economy will be the best method for the analysis of prospect of atomic power in this part of the subcontinent. Great Britain is forced to develop her atomic power as a serious shortage of coal and oil is anticipated there. Her hydro resources are limited.

The problems in India is somewhat different. The total Indian reserves of low grade coal is so far estimated to be 39,000 million tons most of which are located in Bengal-Bihar coal field area. Mine head power stations like those being constructed by D.V.C. could produce power most economically. The hydro potentialities of rivers in India are very prospective. The economical aspect of their

developments should have to be thoroughly studied and compared with nuclear generation.

To operate nuclear power station economically and efficiently it has to be operated at highest possible load factor. We have to make our grid and inter-connectors more extensive and flexible. Our protective and metering equipment should have to be so designed that these could maintain stability, selectivity and sensitivity in the event of quick transfer of load. Technically we have to wait for another decade before the aforesaid facilities are available in India.

J. B. SINGH, Simla.

1. *Different sources of energy.*

(a) Energy for non-commercial uses, mainly from fire-wood, charcoal, cow-dung, farm & forest wastes etc. It is necessary to replace these sources by coal to the utmost extent in the national interest. These may possibly be replaced by coal, coke, kerosene etc. by 50% by the year 1975.

(b) *Coal* :

(c) *Oil* : India's resources are limited in this respect, and even if oil from natural sources is supplemented by synthetic oil from coal, only a very small fraction of future energy requirements can be met.

(d) *Hydro-Power* : Though total Hydro-Electric potential in India is about 35 million kW, economically utilisable potential is of the order of 4 million kW only.

(e) *Nuclear power* :—India is only just entering this field. Potentialities of this source of Power for India is yet a matter for speculation.

2. *Trend of quantitative requirements of coal for power generation :*

Present requirement is about 5 million tons annually. It is expected to rise to 13 million tons annually by end of Third Five-Year Plan. Almost entire requirements of coal in future will have to be met from low-grade coal, immature coals like lignite, bye-products from coal beneficiation Plants like dust and slack coal, middlings from washeries etc.

3. *Plant advancements in power plant design and fuel-burning equipment for utilising low-grade fuels efficiently.*

Improvements in Power Plant design and construction, in recent years are :

(a) Adoption of higher operating steam pressures and temperatures, consequent on evolving steel alloys capable of withstanding such pressures and temperatures.

(b) Improvements in design of boiler furnaces, tending towards increase in proportion of radiant evaporating surface in boilers and adoption of pulverised fuel firing and cyclone firing.

(c) Treatment of boiler water.

(d) Forced circulation boilers.

(e) Adoption of reheat and regenerative cycles.

(f) Advancements in automatic combustion control technique.

(g) Hydrogen cooling of alternators.

These improvements have progressively improved steam power plant efficiencies from an overall station heat rate of about 16000 B.Th.U per kWh in 1910 to about 9000 B.Th.U per kWh at the present day.

4. *Future trend of further developments in steam power plant design in the west.*

- (a) Super-critical steam pressures for power plant.
- (b) "Once-through" boilers.
- (c) Mercury-steam binary cycle.
- (d) Fluidised combustion Technique.
- (e) Gas turbines fed from cyclone furnace.
- (f) Underground gasification of coal.

Chairman : PROF. N. N. SEN, Calcutta.

MEHTA, Y. M. : Alloy Steel.

Regarding the necessity of having various alloy steel castings referred to by my predecessor speaker Dr. Sinha, I would like to point out that it is not economical to produce such castings without a proper demand in the country. The demand, as at present exists, is only haphazard, and more for replacements of broken parts etc. rather than substantive demand of alloy-steel consuming industries. In order to have a good alloy steel casting industry, the machine building and other industries which consumes such castings should necessarily have precedence.

CHAMAN LAL WADHERA : Symposium on Alloy Steel.

There is a sufficient demand for Stainless & High Speed Steel. In 1942 I wrote (from Wazirabad now in Pakistan) to Mysore Iron Bhadrawati to put up a Stainless Steel plant as all the raw material excepting Ni is available in Mysore. Nothing was done but now I understand that Alloy Steel is going to be manufactured at Bhadrawati. Even Stainless Steel Scrap is being exported and it is rather difficult to put up a small scale plant. Alloy Steel has to have quite large plants and I hope that we are going a large production capacity in the public and private Sectors in the near future.

SCIENCE & CULTURAL VALUES IN INDIA

Committee on Science and its Social Relations

Chairman : PROF. P. PARIJA, Cuttack.

U. P. BASU (Calcutta) : Introductory remarks.

Man had to depend on nature for his food, living, comfort and pleasure. Naturally he developed an attitude of fatalism. With the advances of science, however, he has acquired greater self-reliance and has gained power over nature. This has changed his character as well as the intrinsic characteristic of the society to which he belongs. The material, the instrument or the machine that has changed his outlook, has, on the other hand, enslaved him, and his mind is consequently deteriorating. If the mind deteriorates, the community, the race and the civilisation deteriorate. Hence science clashes with culture. A vital question naturally crops up as to how we should develop our science and our creative imagination without affecting adversely our own self, society and country.

In the distant past, if anything happened in any part of the world, it had no reflection elsewhere. The conditions have since changed, and the whole world is so very interlinked that the vibration of an event in any part is at once trans-

mitted to every nook and corner. Our cultural values will, therefore, have to be judged and evaluated along with developments and progress in other parts of the world. As each nation will again have its own tradition, the content of any newer thought should have a relationship with the natural and human environment of the country concerned.

Human attitudes are not immutable, and no society remains static. Change is natural. To live is to change. The point is how this change is to be effected so that it may not affect the whole fabric of the society and the cultural values of the country. Science and technology are progressing at a tremendous speed, and doubt lurks in mind as to whether a country that has a cultural past can keep pace? In any case we will have to work, and work hard in order to achieve our goal or object. No work can be properly accomplished without correct thinking with a right attitude of mind. Once Pasteur was faced with a question that "many discoveries are due to chance". "But chance favours only the ready mind", remarked Pasteur. In the *Bhagavata Gita* (Chap. III, Sloka—4) we find—

न कर्मणामनारम्भान्नैकमर्थं पुरुषोऽनुते

न च संन्यसनादेव सिद्धिं समधिगच्छति

One cannot achieve an object without doing a work with devotion. Mere adoption of a learned profession does not ensure acquirement of wisdom. The question is how we are to develop science and improve upon our cultural traditions. The issue is complex. Many thinkers have assembled here, and the discussions may evolve newer ideas, and throw light on the problem of enriching the mental life of the country.

Abstracts

1. PROF. C. N. VAKIL (Calcutta) : *Social implications of technological change in India.*

Technological change is implied in industrialization, but it is not merely limited in its scope to the mechanization of industry. Technological change is understood in a wider sense as covering the introduction and use of all technical processes in other spheres both productive and non-productive. The cases of fertilizers and tractors in agriculture, and malaria control in medical sciences, may be cited as examples. Urbanization is a concomitant phenomenon—though not always a necessary consequence—of industrialization. In some societies gradually changing social conditions facilitate introduction of innovations and as such technological change is the outcome of an evolutionary process; in some other, technological change is implanted by planning or under exigencies of changing situations.

In a social situation the pre-conditions and present determinants of technological change may be said to comprise its social implications which "can mean, therefore, integrally involved concomitants, antecedents with varying degrees of indispensability and consequences with varying degree of inevitability". Pre-conditions relate to the creation of an entrepreneur class, a reserve force of free labour, economic rationality and creation of savings. Consequences of technological change may be analysed in relation to micro-structures (family), macro-structures (class and caste), attitudes and social disorganization.

In India, technological change was introduced in industry a hundred years ago. Recently, particularly as a result of planning, technological change is being introduced on a wider scale. In so far as the aim of development is to reduce the pressure on land, a greater emphasis may be expected to be laid on industrialization.

The pre-industrial society in India was a static society. Status and work were determined by the fact of birth; a complex web of social regulations and relationships determined the life-conduct and life-changes of the individual in the traditional village-community. Occupation was hereditary, caste-determined, and in some cases highly skilled. The unit of work was often the family. Existence outside the context of the village was not possible. A certainty in the course of life also limited the scope for change.

The cohesion of the village society was broken as a result of the supersession of traditional trades by the import of mass-produced factory goods and the impracticability of fitting in caste-determined occupations in the new job-specifications created by the industrial system. The caste-determined, personalised skill of the blacksmith, carpenter or weaver is superseded by the mass production of the factory. Contractual, impersonal relationships between employer and employee emerge in place of the personal, guild-regulated relations between the craftsman and his apprentices. Various studies reveal the tendency of workers from certain castes or places to concentrate in particular departments or industries. The unit of work is the individual, and his course in life is beset with uncertainty.

A proletariat has been created by increase in population (brought about partly by advance in medical science), though its separate emergence is retarded by ties of the joint family and its commitment to industry by economic and family ties in the village. Villages are the main source of labour. Migration, together with inadequate housing and wage to support family at the place of work as evidenced by the disproportionately low female : male ratio in metropolitan cities, has led to disruption in family life, and consequent social evils. Living conditions in cities are far from desirable and the push-factor is more predominant in fostering migration than the pull-factor.

Technological change on a wider canvas and scale will determine the trend of future consequences. Technological change in agriculture would reduce the force of push-factors in migration from village. The medical science may in future be used to limit population-growth. The scale of industrialization may reduce the extent of migration. A wider understanding of the relations between technological and social forces affecting a society is desirable. With the acceptance of planning, there is need for detailed studies to delineate the social consequences of the process of growth and a concerted attempt to take measures to minimise its harmful consequences.

2. INDRA SEN (Pondicherry) : *Science and culture values in India : Science has to be spiritualised.*

1. Science has made good progress in India, but it came as a transplantation and continues unassimilated culturally. The best creative energies of the people can begin to flow into the channel of scientific inquiry only when it can evoke the energies of our deepest cultural life.

That means that science should become integrated to our culture, i.e., should become a modern expansion of our deepest cultural aspirations.

2. And that is not difficult to achieve. Science is a rational study of the phenomenal existence. Even the method of reason is no absolute commitment. Imagination and intuition do command a recognition in scientific methodology. Phenomenon is the only true differentia of science. But this too is a pragmatic delimitation, since in existence phenomenon is not divided from ultimate reality.

3. If this is true, then it would seem to be easy to liberate science from its European assumption of insistent empiricism and ground it in a wider perspective of ultimate reality, which is temperamentally more congenial to the Indian mind and thoroughly acceptable to the traditions of Indian cultures.

4. Science would then become a study of the ultimate, the True, the Real, the Divine through its manifestation in objective physical nature and subjective psychological mental process. And as such it should thoroughly enthuse the Indian mind to delve into the mysteries of nature, which would then become clearer clues to the deeper mysteries of Self and Existence.

5. This would provide the much needed unity too to modern scientific disciplines. As purely empirical investigations they stand separated, but as approaches to the ultimate, which is one and the same, they can have a sense of unity.

Further, the ultimate as *Satyam, Shivam, Sundaram*, the true, the good, the beautiful, would provide to the phenomenal scientific truth and utility the necessary fuller perspective of life and existence and thus rectify the present imbalance between Science, Morals and Spiritual Values.

6. Science in its own march is showing clearest signs of self-exceeding. It is itself, at least in the field of Physics, probing into the ultimate. It is now quite conscious of the reality of other cultural values too. The time is, therefore, ripe for a wider reorientation, a revision of Francis Bacon's principles of science. And India, because of new cultural traditions, is in a happier position to attempt it.

This might not only much accelerate the progress of science in India, but might also mean a new vision and a new strength to science as a whole.

3. A. RAHMAN (Roorkee) : *Science and culture values in India.*

Science represents the cutting edge for the human advance into an unknown future, technology its widening and concretisation, while culture represents the stabilisation of the two, in a dynamic equilibrium, in a particular period of human evolution. The nature of the advance made is not independent of the other two, in fact is directly dependant upon them, the other two in turn are equally dependent upon each other as well as upon new ideas, however utopian they might be.

Science and technology in India was introduced by the British along with their political domination and consequently it had some of the characteristic social features, *i.e.*, including technological as well as cultural, of British life and thought. The impact on Indian mind was of three types :

(1) British were enslavers, they and everything they introduced must be opposed by every patriot.

(2) British represents a superior culture and they must be copied.

(3) The basis of British civilization represents a new approach to life and therein lies the hope for the future emancipation of India.

The third type represents an appreciation of science and technology, by about the middle of 19th Century and later around Delhi, and is evident from the poems of *Ghalib* and his younger contemporary *Hali*. They advocate a new intellectual approach to problems of every day life. It is not an insignificant fact that *Ghalib's* visit to Calcutta was perhaps the beginning of this impact, as it was there that he saw the nature of Western civilization and the impact it had created in over hundred years.

The complete association of science and technology with bureaucracy, on the one hand and the patriotic sentiments soon reduced this awareness to nothing or very considerably limited it socially. The consequent development of science and technology in India suggests its continued separation from the movement of social change, as against the Western tradition, and hence cultural values. We in India have an antiquated philosophical outlook and a caricature of cultural values on the one hand and its instruments of mass dissemination which we use without knowing the purpose and the end for which these should be used. The intellectual and cultural chaos is the result and is affecting every aspect of our life.

The paper discusses the historical development which have led to the present and are peculiar to India.

4. PROF. N. K. BOSE (Calcutta) : *Science and cultural values in India.*

Each civilization seems to be governed by a particular set of values. These values do not remain constant over long stretches of time, but change with the life experience of a community in course of time. Values occasionally show a peculiar phenomenon. They can be compared with fashions in dress and in other matters. For some time a value system remains in fashion and then is slowly replaced by something else which might be its antithesis or a synthesis born out of compounding it with something which began to influence it from outside.

For long centuries, Indian civilization has been on the whole governed by the desire to find freedom for the soul. This has been interpreted in various ways by various sects. This was not the only system of values current in India. Buddhism, for instance, emphasized mercy and compassion and succeeded in introducing a deep sense of humanism wherever its influence was felt. But of the two strands of thought the former, namely, liberation of soul seems to have been, on the whole, the dominant characteristic of most phases of Indian culture. It was tinged by humanistic considerations; occasionally diluted by secular interests which often reached extremely elaborate proportions. The Arthashastra, Kamasutra and various forms of secular literature give evidence of other systems of values which ruled Indian life apart from the previous ones of liberation and of humanism which have been indicated above.

Science has come today with a great challenge to the Indian mind. Our growing population has almost rent asunder our old productive organization as well as the social system which grew up in conformity with that productive organization, modified as it was by various historical circumstances.

Science fixes its mind upon the tangible. It uses the methods of observation, experimentation and induction for arriving at the truth. Truth derived by intuition is suspect in the eyes of science and therefore such truths as are embodied in the civilizational structure of India and which are derived from intuition, direct personal realization, often unverifiable, and from authority and tradition, have all become suspect in the eyes of modern science.

Science has achieved marvels in the technological sphere, and the hunger and consequent dissatisfaction with poverty which press upon Indian life forces our minds in the direction of science and the scientific method. We grow impatient with methods of knowing truth, like intuition and authority, and our dissatisfaction grows with the past civilization of India which has failed to solve the problem of hunger. In that emotional mood, we become almost blind worshippers of the scientific method and often desire to discard all that is ancient in India without adequate examination. We feel inclined to throw out the baby along with the bucket. What is unfortunate, however, is that in this adoration of science we often behave not as scientists but as blind worshippers of a new god named Science. In reaction against the past, in our desire to destroy the old gods, we create a kind of new god out of science. There is more worship of science as a miracle-worker than of devotion to the scientific method.

It is in this curious condition that we find ourselves in India today. I would not presume to offer a prescription, but what appears reasonable to me is that we can't become better scientists by mere adoration of science and its achievements. We must work out the possibilities of science to the utmost and also be prepared to recognize the limitations to which the scientific method is subject. In other words, our attachment to science must not be blind but be informed by the highest regard for truth. When it comes to values, there are indeed values in Indian civilization which need be preserved just as there are values in all civilizations which are not the private property of any single community but have to be shared in common with the rest of the human family. All experiments in ways of living are eventually property of the entire family of man, if they can be called property

at all. It would be wise if we can rise above temporary emotions, partial needs of the moment, and are able to become truly scientific in the sense outlined above. Truth should demand from us the utmost devotion and in this we must rise above all prejudices born either out of personal experience or of collective communal experiences.

Probably the Liberation or Freedom which thinkers of India aspired to was this liberation of the human mind from prejudices of all kinds. If we can reach that level, when our vision of truth or our search of truth is not twisted in particular directions by local happenings limited by time or space, then we are on the way to the realization of truth much better than in any other manner. And for a mind like that the scientific method may indeed prove to be one of the most admirable tools for the discovery of truth.

5. PROF. A. R. WADIA (Bombay) :

When Hindu civilisation was a living growth science had an important place in it and produced great original mathematicians and great medical geniuses, like Charak and Dhanvantari. But when the spirit of philosophy took complete hold of Indian mind science to a great extent lost its importance, specially with the development of Vedanta. The distinction between the Paramatmika and Vyavaharika, naturally tended to a depreciation of the phenomenal world and it ultimately came to be identified with Maya in Advaita. Science as an attempt to pierce the mysteries of nature lost its value. It is only in recent years under the impact of English education that some of the leading Indians have given themselves up to study of science and made discoveries which have placed India on the map of the scientific world. Perhaps the pendulum in several cases has swung to the other extreme in the sense that the devotion to science has led to a depreciation of philosophy and all humanistic values. This goes entirely against the inheritance of India. But it is noteworthy that even in the West there is a reaction against the supremacy of science and the greatest scientists, like Einstein, Max Planck, Sir James Jeans, Eddington and Whitehead have begun to see the importance of philosophy and there are Nobel Laureates like Dr. Compton who have turned to religion to make up for the crudities of mere science.

It will be good for India and the world if the scientists in India develop a proper equilibrium between what science can do on the one hand and the need for philosophy and religion for human beings to have a balanced outlook.

APPENDIX

LIST OF MEMBERS

HONORARY MEMBERS

Beaufort, L. F., D.Sc., de Hooge Kley, Amersfootz, Netherlands.
Hill, A. V., F.R.S., 16, Bishop Wood Road, Highgate, London N. 6.
Jung, C. G., Professor of Psychology, University of Zurich, Switzerland.
Nehru, Jawaharlal, Prime Minister of India, New Delhi.
Raman, Sir C. V., Kt., F.R.S., Nobel Laureate, Raman Research Institute, Hebbal,
Bangalore.
Visvesvaraya, Sir M., K.C.I.E., 5, Cubban Road, Bangalore.

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